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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

TELEFLEX INCORPORATED,

Plaintiff,

v.

KSR INTERNATIONAL CO.,

Defendant.

Case No. 02 74586

Hon. Lawrence P. Zatkoff

Magistrate Judge Pepe

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TELEFLEX'S RESPONSE TO KSR'S MOTION FOR SUMMARY JUDGMENT OF INVALIDITY

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I. INTRODUCTION

To succeed in its attempt to invalidate the Engelgau Patent, KSR must prove to the Court by clear and convincing evidence that, as a matter of law, it is invalid -- despite the fact that the experts, the United States Patent and Trademark Office, have already affirmed its validity. To do so, KSR has attempted to demonstrate that the Engelgau Patent describes nothing more than an adjustable pedal with an attached electronic control and that it would have been obvious to combine these two features. But KSR's attempt fails because, among other reasons, it has mischaracterized the Engelgau Patent as simply a combination of two known features. Actually, the Engelgau Patent represented a unique way to combine an adjustable pedal with an electronic control -- until that point, many inventors had tried to combine these two elements but none had been able to do so in the way that Engelgau did. As a result, the United States Patent and Trademark Office bestowed on him a patent.

KSR's approach here highlights the true issue between the parties: Whether as a factual question, the Engelgau Patent would have been obvious at the time to one of ordinary skill in the art. This is a question that a jury should decide after the trial (currently scheduled to begin in December 2003). Teleflex respectfully suggests that in light of its dispositive motion on KSR's infringement of the Engelgau Patent, the only viable issues that remain in this case are whether the Engelgau Patent is valid and the amount of damages. Teleflex requests that the Court deny KSR's invalidity motion, grant Teleflex's infringement motion, and allow the jury to decide the issues of validity and, if appropriate, damages.

II. STATEMENT OF FACTS

Teleflex is a leading manufacturer and supplier of adjustable pedal systems that are used by the automotive industry in automobile platforms. Adjustable pedals allow drivers to move the

pedals closer to their feet, enabling them to attain maximum comfort while still sitting as far back from the steering wheel as possible to prevent air bag related injuries.

Some of the Teleflex adjustable pedal systems include an electronic control. An electronic control is a device that senses the depression and release of the pedal and produces an electronic signal corresponding to this movement. Adjustable pedal systems with electronic controls send the electronic signals to the engine to register the pressure applied by the driver on the accelerator, clutch, and/or brake. These adjustable pedal systems are designed to offer enhanced vehicle performance and better control than the traditional pedal system utilizing a cable or rod mechanism. The manufacture and supply of adjustable pedal systems with electronic controls is an expanding and profitable product market.

KSR is also an automotive industry supplier and a Teleflex competitor. KSR also manufactures and sells adjustable pedals that incorporate electronic controls. On its website, KSR claims that it is "an industry leader in the design, engineering and manufacturing of adjustable and fixed brake pedal modules [and] electronic throttle controls . . ." [See, http://www.ksrint.com/about%20ksr.htm] KSR's sales numbers support this claim; KSR's "[a]nnual brake pedal production for adjustable and fixed units exceeds 310 million components assembled into over 14 million modules." [See, http://www.ksrint.com/english.htm] A significant portion of these modules are the type of product at issue in this case — an adjustable pedal with an incorporated electronic control. Indeed, KSR's website touts its electronic throttle control as a "companion to the patented KSR adjustable pedal technology." [See, http://www.ksrint.com/electronic%20throttle%20controls.htm]

In its Second Amended Complaint, Teleflex alleged that certain KSR adjustable pedals with an incorporated electronic control infringe three Teleflex patents: United States Patent No.

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6,237,565, invented by Steven Engelgau ("the Engelgau Patent"); United States Patent No. 6,374,695 ("the '695 Patent") and United States Patent No. 6,305,239 ("the '239 Patent") (together the '695 Patent and the '235 Patent will be referenced as "the Johansson Patents").

The Engelgau Patent claims an adjustable pedal that allows a driver to move the pedal closer to or farther from the driver to achieve maximum driving comfort. It also describes and claims an electronic control that replaces the traditional cable linkage between the pedal and the corresponding part of the vehicle. In the Engelgau Patent, the electronic control module is attached to the mounting bracket of the adjustable pedal and, consequently, it remains fixed both when the pedal arm moves during adjustment and when the pedal arm moves operationally. [See, Ex. A, ¶5.]

The Johansson Patents also describe and claim an adjustable pedal that incorporates an electronic control. The Johansson Patents, however, describe and claim a different design than that described in the Engelgau Patent. Specifically, in the Johansson Patents, the electronic control moves with the pedal during adjustment -- that is, the pedal arm itself moves about one pivot point, and the pedal assembly as a whole moves about a second pivot point.

III. PROCEDURAL HISTORY

On November 18, 2002, Teleflex filed this action against KSR for infringement of the Engelgau Patent and the Johansson Patents. On March 13, 2003, KSR filed a declaratory judgment action in Delaware against Technology Holding, a wholly owned subsidiary of Teleflex, claiming that KSR does not infringe the Engelgau and Johansson Patents and, if it does, that those patents are invalid. The Delaware action is the mirror image of the Michigan action. In it, KSR maintained that Technology Holding, not Teleflex, was the proper party to allege infringement against KSR. On April 2, 2003, KSR filed a Motion to Dismiss for Lack of Subject Matter

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Jurisdiction in this Court. This Court recently denied KSR's Motion to Dismiss as it relates to the Engelgau Patent. The Delaware action has been stayed pending this Court's jurisdictional ruling.[1]

On July 7, 2003, Teleflex filed two Motions for Summary Judgment of Infringement, one relating to the Engelgau Patent and the other relating to the Johansson Patents. On the same day, KSR filed its Motion for Summary Judgment of Invalidity, requesting that the Court declare the Engelgau and Johansson Patents invalid.

The parties recently stipulated to the dismissal with prejudice of the Johansson Patents, which Teleflex has decided to dedicate to the public under 35 U.S.C. § 253. Because of the dismissal of the Johansson Patents, the single remaining claim in this case relates to KSR's infringement of the Engelgau Patent. Based on this recent development, Teleflex's Motion for Summary Judgment of Infringement of Johansson Patents and KSR's arguments relating to the validity of the Johansson Patents are moot. Therefore, in this Response Brief, Teleflex intends to address only KSR's validity arguments regarding the Engelgau Patent. Teleflex will explain in this Response why the adjustable pedal patents and products that KSR cites as prior art do not render the Engelgau Patent obvious. Indeed, this prior art demonstrates why the United States Patent and Trademark Office was correct in deciding to award a patent for the Engelgau invention.

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[1] The simple solution to KSR's concerns regarding jurisdiction would be to have Teleflex amend its Complaint to join Technology Holding as a Plaintiff. In doing so, neither the substance nor timing of this case would change, given that Technology Holding is merely a holding company and does not manufacture, make, or use any parts or patents. For a more detailed discussion of the jurisdictional issue, Teleflex refers the Court to its Response to KSR's Motion to Dismiss for Lack of Subject Matter Jurisdiction.

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IV. APPLICABLE LAW

A. Burden of Proof

Importantly, on the issue of validity, KSR bears the burden of proof. 35 U.S.C. § 282. This burden of proof is not the standard "preponderance of the evidence" burden; rather, KSR must prove invalidity by clear and convincing evidence. Elmer v. ICC Fabricating, Inc., 67 F.3d 1571, 1574 (Fed. Cir. 1995).[2] KSR must meet this burden because once a patent has been granted, it is presumed to be valid, primarily because the United States Patent and Trademark Office subjects a patent application to rigorous scrutiny; the presumption of validity requires that the decision-maker employ an approach "that starts with the acceptance of the patent claimed as valid and that looks to the challenger for proof to the contrary." Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1534 (1983).[3]

Moreover, a party that asserts invalidity "not only has the procedural burden of proceeding first in establishing a *prima facie* case, but the burden of persuasion on the merits remains with that party until a final decision." Stratoflex, 713 F.2d at 1534 (emphasis added). According to the United States Supreme Court, in order to demonstrate a proposition by clear and convincing evidence, the party carrying the burden must "place in the mind of the ultimate fact finder an **abiding conviction** that the truth of its factual contentions are 'highly probable.'"

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[2] The Court of Appeals for the Federal Circuit maintains exclusive appellate jurisdiction over civil suits that arise under the federal patent laws. See, J. Thomas McCarthy, McCarthy's Desk Encyclopedia of Intellectual Property, Second Edition, p. 104.

[3] See, SIBIA Neurosciences, Inc. v. Cadus Pharmaceutical Corp., 225 F.3d 1349, 1355 (Fed. Cir. 2000); Robotic Vision Systems, Inc. v. View Engineering, Inc., 189 F.3d 1370, 1377 (Fed. Cir. 1999) ("There is a strong presumption of validity for issued patents . . . therefore an accused infringer who raises patent invalidity as a defense bears the burden of showing invalidity by facts supported by clear and convincing evidence."); Avia Group, Int'l, Inc. v. L.A. Gear California, Inc., 853 F.2d 1557, 1567 (Fed. Cir. 1998) (granting motion for summary judgment of non-obviousness).

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Colorado v. New Mexico, 467 U.S. 310, 316, *reh'g denied*, 468 U.S. 1224 (1994), *quoting* C. McCormick, Law of Evidence 320, p. 679 (1954) (emphasis added). Thus, for purposes of its motion for summary judgment, KSR must prove by clear and convincing evidence that there is no genuine issue of material fact that the design depicted in the Engelgau Patent would have been obvious to one of ordinary skill in the art -- despite the fact that the United States Patent and Trademark Office found the patent to be valid.

B. Obviousness

1. Test for Obviousness

In order to prove that a patent claim is invalid as obvious, a party must demonstrate that the differences between the claimed invention as a whole and the prior art "are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. § 103.[4] An obviousness inquiry is highly fact specific, and requires an examination of the following: (1) the scope and content of the prior art; (2) the differences between the patented invention and what already existed in the prior art; (3) the ordinary level of skill of people working in the field; and (4) other objective evidence which may suggest that the invention would not have been obvious. Graham v. John Deere Co., 383 U.S. 1, 17-18; 86 S. Ct. 684; 15 L. Ed.2d 545 (1966); Ashland Oil, Co. v. Delta Resins & Refractories, Inc., 776 F.2d 281, 291 (Fed. Cir. 1985). The facts here argue against KSR's invalidity motion.

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[4] Prior art encompasses the existing body of technological information against which an invention is judged to determine if it is patentable as being a novel and nonobvious invention. See, J. Thomas McCarthy, McCarthy's Desk Encyclopedia of Intellectual Property, Second Edition, p. 341.

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2. Combination of Elements within the Prior Art

An accused infringer who challenges a patent on obviousness grounds is essentially admitting that no one piece of prior art describes the invention; instead, the infringer is saying that if one were to choose certain aspects of prior art and then mix and match them, one would arrive at the patent-in-suit (here, the Engelgau Patent). Courts have traditionally been skeptical of this approach because, at some level, virtually all inventions are combinations of old elements.[5] Indeed, in hindsight, many inventions seem obvious. Therefore, courts have held that there must be some **suggestion** to combine specific prior art in such a way as to arrive at the particular combination disclosed in the patent at issue. See, e.g., Yamanouchi Pharmaceutical Co., 231 F.3d at 1343 ("To counter this potential weakness in the obviousness construct, the suggestion to combine requirement stands as a critical safeguard against hindsight analysis and rote application of the legal test for obviousness."); Heidelberger Druckmaschinen AG v. Hantscho Commercial Prods., 21 F.3d 1068, 1072 (Fed. Cir. 1994). In other words, there must be "something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination."[6]

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[5] See, Yamanouchi Pharmaceutical Co., Ltd. v. Danbury Pharmacal, Inc., 231 F.3d 1339, 1343 (Fed. Cir. 2000) *quoting* In Re Rouffet, 149 F.3d 1350, 1357-58 (Fed. Cir. 1998) ("If identification of each claimed element in the prior art were sufficient to negate patentability, very few patents would ever issue. Furthermore, rejecting patents solely by finding prior art corollaries for the claimed elements would permit an examiner [or accused infringer] to use the claimed invention itself as a blueprint for piecing together elements in the prior art to defeat the patentability of the claimed invention.").

[6] See, Interconnect Planning Corp. v. Feil, 774 F.2d 1132, 1143 (Fed. Cir. 1985); Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc., 807 F.2d 955, 959 (Fed. Cir. 1986) (a patent will not be deemed invalid merely because it is made up of a 'combination of old elements.'); SmithKline Diagnostics, Inc. v. Helena Labs. Corp., 859 F.2d 878, 887 (Fed. Cir. 1988) ("A finding that claims which combine several prior art references are invalid based merely upon the fact that those similar elements exist is 'contrary to statute and would defeat the congressional purpose in enacting Title 35.'").

This requirement of a suggestion to combine prior art to demonstrate obviousness prevents hindsight reconstruction by accused infringers, like KSR, who try to use the patent-in-suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims in suit. Grain Processing Corp. v. American Maize-Products Corp., 840 F.2d 902, 907 (Fed. Cir. 1988). See also, Ecolochem, Inc. v. Southern California Edison Co., 227 F.3d 1361, 1371 (Fed. Cir. 2000) ("[T]he best defense against hindsight-based obvious analysis is the rigorous application of the requirement for a showing of a teaching or motivation to combine the prior art references. . . . Combining prior art references without evidence of such a suggestion, teaching, or motivation simply takes the inventor's disclosure as a blueprint for piecing together the prior art to defeat patentability -- the essence of hindsight."). It is well-established that the showing of the motivation to combine references must be "clear and particular."

In Heidelberger, supra, the assignee of a patented device called a "chopper," which folded sheets of printed matter as they emerged from a printing press, sued a printing press manufacturer for infringement. The defendant alleged that the patent was invalid for obviousness. Although each of the elements of the patent could be found somewhere within the prior art, the Federal Circuit rejected the obviousness challenge and emphasized that "the several prior art choppers were encumbered by limitations and disadvantages that had not previously been overcome." Heidelberger, 21 F.3d at 1072. Moreover, several companies, including the defendant, had tried and failed to meet the particularized need for a precise and high-speed chopper. By combining a "double offset circle drive mechanism" with a "printing press chopper," the patentee was able to overcome many of the limitations that had hindered progress in this area. Explicitly noting that "[t]he motivation to combine references can not come from the invention itself," the court

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held that "[t]here is nothing in the prior art to lead a person of ordinary skill to the combination of the structures in these references to design a high-speed chopper for use in rotary printing presses, other than the hindsight knowledge of [the inventor's] construction." Id. See also, Ecolochem, supra, 227 F.3d at 1371 ("'Hindsight reconstruction' cannot be used 'to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.'"); ATD Corp v. Lydall Inc., 159 F.3d 534, 546 (Fed. Cir. 1998); Winner International Royalty Corp. v. Wang, 202 F.3d 1340, 1348 (Fed. Cir. 2000).

If it were sufficient for a party to simply demonstrate that all of the elements of a claim are found in multiple patents, virtually all patents would be invalidated on obviousness grounds. Lindemann Maschinefabrik Gmbh v. American Hoist and Derrick Company, 730 F.2d 1452 (Fed. Cir. 1984), is instructive in this regard. In Lindemann, the patent at issue related to a machine used for crushing massive metal scrap. The invention combined one feature previously used in a garbage compactor with a second feature found in a large shearing device. The Federal Circuit held that the district court's broad definition of the problem as "the problem of compressing waste materials" was clearly erroneous and reversed the holding of obviousness. Id. at 1460. "That the claimed invention may employ known principles does not in itself establish that the invention would have been obvious. Most inventions do." Id. at 1462.

Significantly, courts routinely hold that it is a question of fact whether a party has established the requisite motivation to combine. See, e.g., Winner International Royalty Corp., supra, 202 F.3d at 1348; Emerson Electric Co. v. Spartan Tool, LLC, 223 F. Supp.2d 856 (N.D. Ohio 2002).

3. Problem Addressed by the Invention

In determining whether a particular combination of prior art would be obvious, a court is to consider the nature of the problem that the inventor was trying to solve. The problem confronting the inventor is significant because whether one of ordinary skill in the art would find a particular combination to be obvious depends on whether this hypothetical person was confronted with the same problem as the inventor. See, In Re Rouffet, 149 F.3d at 1357 (to make a finding of obviousness, there must be evidence that "a skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed").[7] In other words, an obviousness challenge must fail if it does not frame the challenge in terms of the problem confronted by the inventor.

V. ARGUMENT

A. Summary of Argument

KSR claims that the Engelgau Patent is obvious. However, before the Engelgau Patent, no inventor had combined, in the way that Engelgau did, an adjustable pedal and an electronic control **so that the electronic control was attached to the pedal mounting bracket.** The Engelgau Patent represented a departure from the evolution of the relevant prior art in the fields of pedal assemblies and electronic controls. Initially, there were fixed pedals with cable-actuated

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[7] See also, WMS Gaming, Inc. v. International Game Technology, 184 F.3d 1339, 1359 (Fed. Cir. 1999) (court found that patent was not obvious where prior art in gaming technology did not teach decreasing odds of winning, which was a critical element of the patent at issue, and the stated objectives of the prior art patents was to "overcome the deficiencies of mechanical reels, such as noise and being susceptible to wear and tampering"); Aero Industries, Inc. v. John Donovan Enterprises-Florida, Inc., 80 F. Supp. 2d 963, 975 (S.D. Ind. 1999) (court held that the alleged infringer failed to demonstrate that the prior art was "reasonably pertinent" to the problem that the inventor attempted to solve).

throttle control mechanisms. Subsequently, inventors replaced cables with electronic controls on these fixed pedal assemblies. These electronic controls were attached to the pedal itself. The next significant inventions were adjustable pedals with electronic controls. In the early adjustable pedal with electronic control designs, the electronic control was attached directly to the pedal, in the same manner that those electronic controls had been attached to fixed pedal assemblies. The novelty of the Engelgau Patent stems from the decision to separate the pedal from the electronic control. Engelgau viewed this change as a way to overcome the major disadvantage of prior adjustable pedal/electronic control designs: They were complicated and expensive to assemble and took up a significant amount of packaging space. [See, Ex. A, ¶7.]

KSR's invalidity challenge fails because it is built on an erroneous assumption. KSR assumed that the problem that the inventor, Steven Engelgau, wanted to solve was the following: How to attach an electronic control to an adjustable pedal. Having made this assumption, KSR found prior art that solved this problem -- the combination of the Asano adjustable pedal patent (United States Patent No. 5,010,782) and the CTS 503 Series electronic control. It then concluded that a typical pedal engineer who needed to attach an electronic control to an adjustable pedal assembly would have known to combine an assembly like Asano with an electronic control like the CTS sensor.

But this house of cards falls because the problem that Engelgau was trying to solve was not simply the combination of an adjustable pedal with an attached electronic control. Rather, Engelgau tried to invent an adjustable pedal assembly with an electronic control that was less complex, less expensive, and easier to package than its predecessors. [See, Ex. A, ¶7.] In particular, Engelgau needed to develop an adjustable pedal with electronic control that would allow the movement of the pedal back and forth within a narrow pedal compartment; he solved

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his space constraints by (among other means) placing the electronic control on the pedal mounting bracket as opposed to the variety of other locations at which he could have placed the electronic control. [See, **Ex. A**, ¶8.]

The Engelgau patent examiner had before him several examples of adjustable pedals and electronic controls -- including prior art that is actually closer to the Engelgau Patent than that cited by KSR here -- but none of these examples suggested a combination like the one that Engelgau invented.[8] Because no other person had invented an adjustable pedal assembly with electronic control that placed the electronic control on the pedal mounting bracket like Engelgau did, the United States Patent and Trademark Office issued a patent to Engelgau.

B. No Teaching or Suggestion in Prior Art to Combine the Elements in the Manner Specified in Claim 4 of the Engelgau Patent

Obviousness determinations are made by placing oneself in the shoes of a person of ordinary skill in the art.[9] Teleflex's experts are Professor Clark Radcliffe and Timothy Andresen. Dr. Radcliffe is a professor of mechanical engineering at Michigan State University; Mr. Andresen is an automotive pedal engineer with 26 years of experience at Ford Motor Company. Both have concluded that the Engelgau Patent involved a combination of elements that

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[8] The most pertinent prior art references for purposes of this Motion are United States Patent Nos. 5,632,183; 4,915,075; 4,958,607; 5,233,882; and 5,887,488. [See, **Exs. B, C, D, E, F.**] The relevancy of these patents will be discussed in greater detail below. Attached as **Exhibit G** is the form that the patent examiner used to indicate the prior art that he considered.

[9] Teleflex defines a person of ordinary skill in the art as one with an undergraduate degree in mechanical engineering (or an equivalent amount of industry experience) who has familiarity with pedal control systems for vehicles. KSR's definition sets a lower threshold of a person with "a minimum of two (2) years of college level training in mechanical engineering and two-three years' work experience spanning at least one complete pedal design 'cycle'." [See, Brief in Support of KSR's Motion for Summary Judgment on Invalidity ("Invalidity Brief"), p. 18.] Regardless of which definition this Court chooses to adopt, the obviousness analysis would remain substantially unaffected.

would not have been obvious to one of ordinary skill in the art. [See, **Ex. H, ¶14; Ex. I, ¶¶7,9.**] Conversely, neither Larry Willemsen nor Daniel Kruger (whose Declarations KSR attached to KSR's Motion for Summary Judgment) have offered any opinion regarding whether the combination found in the Engelgau design would have been obvious to one of ordinary skill in the art. See, Wesley Jessen Corp. v. Coopervision, Inc., 207 F. Supp.2d 1103, 1109 (C.D. Cal. 2002) (court denied summary judgment on invalidity where the defendant's expert "does not state in either his declaration or deposition that the language of the [prior art] patent suggested to a person of ordinary skill in the art that the Knapp patent should be combined with the LeGrand-Fuhrman lenses").[10]

KSR has done little to meet its substantial burden of demonstrating that Professor Radcliffe and Mr. Andresen are wrong. In fact, KSR has done nothing more than claim that both adjustable pedals and electronic controls existed within the prior art. This is far from sufficient to carry the burden of proving that this combination **in the manner claimed in Claim 4 of the Engelgau Patent** would have been obvious to one of ordinary skill in the art. As explained in Subsection IV.B of this Brief, before this Court can declare the Engelgau Patent invalid, KSR must demonstrate, among other things, that there was some teaching or suggestion in the prior art to combine the elements in the manner specified in the claim. See, e.g., Ecolochem, Inc., supra, 227 F.3d at 1371. KSR seeks to satisfy the motivation requirement by arguing that the prior art includes "specific teachings with respect to the desirability of electronic, as distinguished from mechanical, throttle controls in automotive vehicles" and, in particular, includes teaching of the desirability of employing "linkages between vehicle accelerator pedals and engine

[10] Even if KSR belatedly offered opinions from Mr. Willemsen and Dr. Kruger, these opinions would be suspect because Mr. Willemsen is a KSR employee and Dr. Kruger's background is in aerospace, not automotive, engineering.

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throttles" and of locating an electronic pedal position sensor "inside the vehicle's passenger compartment, rather than in a vehicle's engine compartment." [See, Invalidity Brief, p. 23-24.]

KSR claims that Teleflex's motivations for combining Asano with an of-the-shelf electronic pedal position sensor are at least as convincing as the motivations that the Federal Circuit found sufficient to prove obviousness in the following cases: Ryko Manufacturing Co. v. Nu-Star Co., 950 F.2d 714, 717 (Fed. Cir. 1991); Novo Nordisk A/S v. Becton Dickinson & Co., 304 F.2d 1216 (Fed. Cir. 2002); Richardson-Vicks, Inc. v. Upjohn Co., 122 F.3d 1476 (Fed. Cir. 1997). KSR's argument would only have merit if the problem confronted by Engelgau were as simple as KSR seeks to characterize it – that is, merely combining an adjustable pedal assembly with an electronic control.

Such simplistic combinations are the defining characteristic of the cases cited by KSR. For instance, in Ryko Manufacturing Co., the Federal Circuit characterized the "difference between the prior art and the claim at issue [as] essentially the substitution of a keypad code device for a coin box or other common input device." There, the problem that the inventor tried to solve was putting a keypad code in an automatic car wash. Because the keypad entry system that the patentee combined with an automatic car wash was prevalent in the prior art, and there was nothing unique about the structure of the combination, the court deemed the patent invalid as obvious.

Similarly, in Richardson-Vicks, Inc. v. Upjohn Co., 122 F.3d 1476 (Fed. Cir. 1997), the court held that the combination of two well-known medications into one tablet for the relief of cough, cold and flu symptoms was invalid as obvious. There, the problem that the inventor tried to solve was putting two common medications together. The overriding factor in the court's

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analysis was that doctors had long prescribed both medications together, although not combined into one mixture, for that very purpose.

Finally, in Novo Nordisk A/S v. Becton Dickinson & Co., 304 F.2d 1216 (Fed. Cir. 2002), the relevant claim involved an injection pen with 30 gauge needles. The prior art included pen-style insulin injection systems that either did not state the needle size or showed needles of 27 and 28 gauge. In addition, the prior art included 30 gauge needles for insulin injections. The court determined that there was nothing unique about the manner in which the inventor combined the two elements from the prior art.[11]

Again, these cases are inapposite because they address situations in which the problems that the inventors tried to solve simply required the perfunctory combination of common elements. Here, the actual problem that Engelgau confronted -- as distinguished from the fictional problem that KSR fabricates in its brief -- could not be solved by the routine combination of common elements.

C. KSR Mischaracterized Problem Solved by the Engelgau Patent

KSR's entire invalidity argument is based on an erroneous assumption. KSR has claimed that the problem faced by Engelgau could have been solved by combining the design of the Asano patent with any off-the-shelf electronic throttle control like the CTS 503 Sensor. However, combining Asano with an electronic control would not have solved any of the problems confronting Engelgau in his design of the Engelgau Patent.

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[11] Moreover, the Federal Circuit in Novo Nordisk merely upheld a jury's verdict that the invention was obvious. Affirming a jury verdict involves a far more lenient standard than this Court faces in ruling on a motion for summary judgment. The Novo Nordisk court merely had to determine that a reasonable jury could have found that the invention was obvious. Conversely, KSR asks this Court to find, as a matter of law, that no reasonable jury could find that the invention was not obvious.

KSR acknowledges that "[t]he relevant art is defined by the nature of the problem confronting the would-be inventor." [See, Invalidity Brief, p. 21.] However, KSR has mischaracterized the problem facing Mr. Engelgau at the time that he developed the Engelgau Patent in order to ease its burden of proving obviousness. KSR has claimed that "the 'problem' ostensibly confronting the '565 inventor was to provide an adjustable pedal assembly that could be installed in a vehicle whose engine utilized an electronic, rather than a cable-actuated, throttle control system." [See, Invalidity Brief, p. 21.] But this was not the essence of the problem Engelgau confronted. Indeed, the Engelgau Patent concedes that adjustable pedals for use with engines utilizing electronic throttle control systems were known in the prior art. In fact, in the section of the Engelgau Patent entitled "Background of the Invention," the patent states that "[o]ne such adjustment apparatus used with an electronic throttle control is shown in U.S. Pat. No. 5,819,593 assigned to the assignee of the present invention." [See. **Ex. J**, Col. 1, lines 43-47.] Clearly, therefore, KSR's characterization of the problem addressed by Engelgau cannot be correct.

Rather, as expressly stated in the Engelgau Patent, the problem that Engelgau confronted was developing a pedal assembly that not only "includes both an adjustment apparatus and an electronic control" but that is not expensive, time consuming to assemble, and that does not require a significant amount of packaging space. [See, **Ex. J**, col. 1, lines 48-53.] KSR disingenuously ignores multiple, credible references to the actual problem confronted by Engelgau. In its First Set of Interrogatories, KSR requested that Teleflex "identify each and any problem that Teleflex contends (a) was [solved by] any claimed invention of any Patent-in-Suit; and (b) was not solved by any pedal assembly disclosed in the prior art of any of the Patents-in-Suit." Teleflex responded as follows:

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> To the extent that this interrogatory asks which problem or problems Teleflex contends were intended to be solved by the Teleflex Automotive Patents, Teleflex responds as follows: as for the '565 Patent, **Teleflex attempted to provide a design for an adjustable pedal system with electronic control that would address issues of packaging, assembly, and cost . . .**

(emphasis added). Teleflex's response mirrored the text of the Engelgau Patent which sets forth the background of the invention and provides a detailed explanation of the problem that Engelgau set out to solve.

> When a vehicle control pedal assembly includes both an adjustment apparatus and an electronic throttle control, the pedal assembly can be complex with a great number of parts. These control pedal assemblies can be expensive, time consuming to assemble, and require a significant amount of packaging space.

[See, **Ex. J**, col. 1, lines 48-53.] The "Summary of the Invention and Advantages" section of the Engelgau Patent further explains that "the subject invention provides a simplified vehicle control pedal assembly that is less expensive, and which uses fewer parts and is easier to package within the vehicle." [See, **Ex. J**, col. 2, lines 2-5.]

There were various possible ways that Engelgau could have sought to resolve this problem and there was nothing in the nature of the problem that inexorably led him to the design of the Engelgau Patent. For example, Engelgau could have placed the electronic control in any number of locations within the vehicle, such as inside the engine compartment, on a vehicle firewall spaced from the mounting bracket, on a vehicle dashboard, or on a different type of adjustment element. [See, **Ex. A**, ¶8.]

D. KSR's Misuse of Prior Art

Because KSR cannot demonstrate motivation to combine by looking at the prior art **at the time of the Engelgau Patent**, it engaged in an improper hindsight analysis. That is, KSR started with the elements of the Engelgau Patent and then attempted to locate each of those elements in the prior art. Courts have been careful to prevent hindsight reconstruction by accused infringers

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like KSR who try to use the patent-in-suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims in suit. See, Grain Processing Corp, supra, 840 F.2d at 907. If this were the proper way to test for obviousness, virtually every patented invention would be deemed invalid. Rather, the appropriate way to view obviousness is to ask whether, without knowing of the Engelgau Patent, the prior art references make obvious Engelgau's solution to the problem of developing an inexpensive, more easily assembled, and more conveniently packaged adjustable pedal assembly with electronic control. This question must be answered in the negative.

1. Asano Pedal Involved a Complex Design that Could Not Have Motivated Solution to Problem Solved by Engelgau

The Engelgau Patent provided a feature previously unavailable, specifically, an "electronic throttle control attached to the support for controlling an engine throttle." This electronic control responded to the pivotal motion of the adjustable pedal at the support, thereby providing a simpler mounting position that was both less expensive and easier to package than devices in the prior art. [See, **Ex. A, ¶7; Ex. H, ¶15.**] Contrary to KSR's suggestions, it would not have made sense for Engelgau to combine the design of the Asano patent with the CTS 503 Series pedal position sensor in order to create an adjustable pedal with ETC that would be inexpensive, easily assembled, and would utilize less vehicle space. First, the Asano patent nowhere discloses an adjustable pedal assembly that includes an electronic control. Nor does KSR point to any teaching or suggestion in the Asano patent to incorporate an electronic control into the pedal assembly, let alone any suggestion that it be incorporated in the manner specified in Claim 4 of the Engelgau Patent. Second, the Asano patent is directed to an entirely different problem than that confronted by Engelgau. Asano addressed the problem of developing an adjustable pedal in which the force applied to the pedal "is held substantially constant under the same pivotal

displacement distance of the pedal pad caused by a driver's depression action of the pedal, irrespective of the adjusted pedal pad position." [See, Ex. K, col. 1, lines 57-60.][12] In other words, Asano wanted to invent an adjustable pedal that would require the same pressure to move the pedal regardless of where the pedal was located on the adjustment spectrum.

In order to solve this problem, Asano developed a complex mechanical assembly that was expensive, time consuming to assemble, and required a significant amount of packaging space.

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[12] The "Summary of the Invention" section of the Asano patent sets forth the goals that the inventor sought to accomplish and the problem(s) that the design was intended to solve:

> Therefore, it is an object of the present invention to provide a pedal assembly for a vehicle which enables a position of a pedal pad . . . to be adjusted forwardly and rearwardly of the vehicle, i.e. in a longitudinal direction of the vehicle, wherein a force applied to an operating member which transmits the applied force to a vehicle operation system such as a braking system, an engine throttle valve and a clutch system, is held substantially constant under the same pivotal displacement distance of the pedal pad caused by a driver's depression action of the pedal, irrespective of the adjusted pedal pad position.
>
> Another object of the present invention is to provide a position adjustable pedal assembly, wherein a required depression force or leg power for depressing the pedal pad by the same distance is maintained substantially constant, irrespective of the adjusted pedal pad position.
>
> A further object of the present invention is to provide a position adjustable pedal assembly, wherein a full depression displacement distance of the pedal pad in circumferential direction is held substantially constant by using adjustable stopper means, irrespective of the adjusted pedal position.
>
> A still further object of the present invention is to provide a position adjustable pedal assembly, wherein a reaction force applied to components of the pedal assembly in the direction along a length of the vehicle, i.e. in the longitudinal direction of the vehicle to be generated in response to the depression force applied to the pedal pad by the driver is considerably reduced so as to attain the strength of the pedal assembly as well as smooth pedal operation feelings.

[See, Ex. K, col. 1, lines 48-68; col. 2, lines 1-12.] Clearly, none of the objectives that Engelgau sought to address were considered by Asano.

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[See, **Ex. A, ¶10; Ex. H, ¶16.**] Thus, someone in Engelgau's shoes, who was trying to create an adjustable pedal assembly with an attached electronic control that was easy to package in a narrow space and was also relatively simple and inexpensive, would shun Asano.

2. Patent Examiner Review of Prior Art

Significantly, the Engelgau patent examiner considered a patent that was far closer to the Engelgau Patent than was the Asano patent; he also considered numerous patents that were analogous to the CTS 503 Series pedal position sensor. Having considered these superior references, the examiner still allowed the Engelgau Patent to issue. The reference that is superior to Asano is United States Patent No. 5,632,183 ("the Rixon '183 patent"), which was invented by another Teleflex employee and a co-worker of Engelgau. [See, **Ex. B.**] The patents that are analogous to the CTS 503 Series pedal position sensors are United States Patent Nos. 4,915,075 ("the '075 patent"); 4,958,607 ("the '607 patent"); 5,233,882 ("the '882 patent"); and 5,887,488 ("the '488 patent") (collectively referred to as "the cited electronic sensor patents") [See, **Exs. C, D, E, F.**]

KSR does not discuss the Rixon '183 patent at all in its Invalidity Brief because KSR recognizes that the Rixon '183 patent is closer to the Engelgau patent than is the Asano patent. Similarly, KSR did not discuss any of the cited electronic sensor patents in its Invalidity Brief because KSR recognized that these patents are at least equivalent to the CTS 503 Series pedal position sensor. In other words, the patent examiner considered the same, or better, prior art than that presented by KSR and determined that the Engelgau Patent was not obvious based on the teachings in that prior art

3. KSR's Discussion of the Rixon '593 Patent

KSR briefly discusses another Teleflex patent, namely United States Patent No. 5,819,593 ("the Rixon '593 patent") in its Invalidity Brief. [See, **Ex. L.**] Unlike the Asano Patent which lacks an electronic control, the Rixon '593 patent depicts an adjustable pedal assembly with electronic control. Therefore, KSR's suggestion that "the 'problem' ostensibly confronting the '565 inventor was to provide an adjustable pedal assembly that could be installed in a vehicle whose engine utilized an electronic, rather than a cable-actuated throttle control system" is completely erroneous. The Rixon '593 patent had already solved that problem. Moreover, given that the inventor of the '593 patent had assigned his invention to Teleflex, there would have been no motivation for Teleflex to engage Engelgau to find a solution to a problem that had already been solved by one of its own employees.

The adjustable pedal assembly depicted in the Rixon '593 patent contains an electronic control situated away from the pedal assembly's support, thereby requiring more complex mounting -- both mechanically and electrically -- than the Engelgau Patent. The complexity, cost and packaging difficulties associated with the Rixon '593 patent highlighted the problem subsequently addressed by the Engelgau Patent. [See, **Ex. A, ¶7; Ex. H, ¶17.**]

E. Secondary Considerations of Non-Obviousness Bolster Teleflex's Position that the Engelgau Patent Is Valid

Commercial success represents an objective indicator of non-obviousness. See, Avia Group Int'l, Inc. v. L.A. Gear California, Inc., 853 F.2d 1557, 1563-64 (Fed. Cir. 1988). Teleflex has experienced considerable commercial success with its adjustable pedal assemblies conceived from the Engelgau Patent. For example, Teleflex's adjustable pedal assembly design has been placed in Ford's U-137/P-131 program. [See, **Ex. M, ¶3.**] The U-137/P-131 program vehicles are the Ford Excursion, F-250, and F-350. [See, **Ex. M, ¶4.**] To date, Teleflex has

shipped approximately 150,000 adjustable pedal units to Ford for the U-137/P-131 program. [See, Ex. M, ¶5] In addition, upon information and belief, the GMT-800 and GMT-360 platforms are large-volume programs, further demonstrating the commercial success of Engelgau's invention.

VI. CONCLUSION

Based on the stipulated dismissal with prejudice of Teleflex's claim for infringement of the Johansson Patents, this Court need not make any findings with respect to the validity or invalidity of the Johansson Patents. With respect to the Engelgau Patent, KSR has failed to demonstrate via clear and convincing evidence that the combination of elements found in the Engelgau Patent would have been obvious to one of ordinary skill in the art. At least, this is an issue of disputed fact to be decided by a jury. Therefore, Teleflex respectfully requests that this Court deny KSR's Motion for Summary Judgment on Invalidity of the Engelgau Patent in its entirety.

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BY: Rodger D. Young

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248.353.8620

Date: August 11, 2003

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

TELEFLEX INCORPORATED,

Plaintiff,

v.

KSR INTERNATIONAL CO.,

Defendant.

Case No. 02 74586

Hon. Lawrence P. Zatkoff

Magistrate Judge Pepe

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AFFIDAVIT OF STEVEN ENGELGAU

I, Steven Engelgau, being duly sworn, depose and state as follows:

1. I am the named inventor of United States Patent No. 6,237,565 ("the Engelgau Patent").

2. I invented the Engelgau Patent while employed by Teleflex Incorporated.

3. I assigned the Engelgau Patent to Teleflex Incorporated.

4. I no longer work for Teleflex.

5. The Engelgau Patent describes and claims an adjustable pedal that allows a driver to move the pedal closer to or farther from the driver to achieve maximum driving comfort. It also describes and claims an electronic control that replaces the traditional cable linkage between the pedal and the corresponding part of the vehicle. In the Engelgau Patent, the electronic control module is attached to the mounting bracket of the adjustable pedal and, consequently, it remains fixed when the pedal arm moves.

6. Before designing the Engelgau Patent, I was generally aware of the various designs in the fields of fixed and adjustable pedal assemblies as well as electronic controls. I was specifically aware of various combinations of fixed and adjustable pedal assembly with electronic controls, including United States Patent No. 5,819,593 ("the Rixon '593 patent"), and the electronic control used on General Motor Corporation's fixed pedal.

7. My goal in designing the Engelgau Patent was to invent an adjustable pedal assembly with an electronic control that was less complex, less expensive, and easier to package than its predecessors. In particular, I sought to develop an adjustable pedal with electronic control that would allow the movement of the pedal back and forth within a narrow, confined pedal space.

8. I accomplished my goal by (among other things) placing the electronic control on the vehicle mounting structure. There were various possible solutions that I considered before concluding that the electronic control would be best situated there. In particular, I considered the advantages and disadvantages and overall feasibility of placing the electronic control in various locations within the vehicle.

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9. To the best of my knowledge, at the time I invented the Engelgau Patent, no other person had invented an adjustable pedal assembly with electronic control that placed the electronic control on the pedal mounting structure.

10. I am familiar with the Asano patent, United States Patent No. 5,010,782. It would not have made sense for me to combine the design of the Asano adjustable pedal assembly with an electronic control because the Asano design contained a complex mechanical assembly that is expensive, time consuming to assemble, and takes up a significant amount of packaging space -- precisely the problem that I was attempting to solve in designing the Engelgau Patent.

Steven Engelgau

Dated: 8-11-03

Subscribed and sworn to before me
on this 11 day of August, 2003.

Notary Public LINDA R. WYNN
OAKLAND County,
My Commission Expires: 9-11-03

LINDA R. WYNN
Notary Public, Oakland County, MI
My Commission Expires Sept. 11, 2003

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US005632183A

United States Patent [19]

[11] Patent Number: 5,632,183

Rixon et al.

[45] Date of Patent: May 27, 1997

[54] **ADJUSTABLE PEDAL ASSEMBLY**

[75] Inventors: Christopher J. Rixon, Tecumseh, Canada; Christopher Bortolon, Clawson, Mich.

[73] Assignee: Comfort Pedals, Inc., Warren, Mich.

[21] Appl. No.: 513,017

[22] Filed: Aug. 9, 1995

[51] Int. Cl.[6] G05G 1/14

[52] U.S. Cl. 74/512; 74/560

[58] Field of Search 74/478, 512, 513, 74/514, 560; 403/109, 377

[56] References Cited

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Primary Examiner—Charles A. Marmor
Assistant Examiner—Mary Ann Battista
Attorney, Agent, or Firm—Young & Basile, P.C.

[57] **ABSTRACT**

An adjustable control pedal apparatus for a motor vehicle. The pedal assembly is slidably mounted at its upper end on a single hollow guide rod extending rearwardly from a transmission housing which in turn is pivotally mounted to a bracket secured to the firewall of the vehicle. A nut is positioned slidably within the hollow guide rod and a screw shaft extends rearwardly from the transmission housing for threaded engagement with the nut. A key extends from the nut to the pedal assembly so that linear movement of the nut within the hollow rod as generated by rotation of the screw shaft results in forward and rearward movement of the pedal assembly along the guide rod. The screw shaft is driven by a transmission positioned in the transmission housing and the transmission is in turn driven by a cable driven by an electric motor.

15 Claims, 3 Drawing Sheets

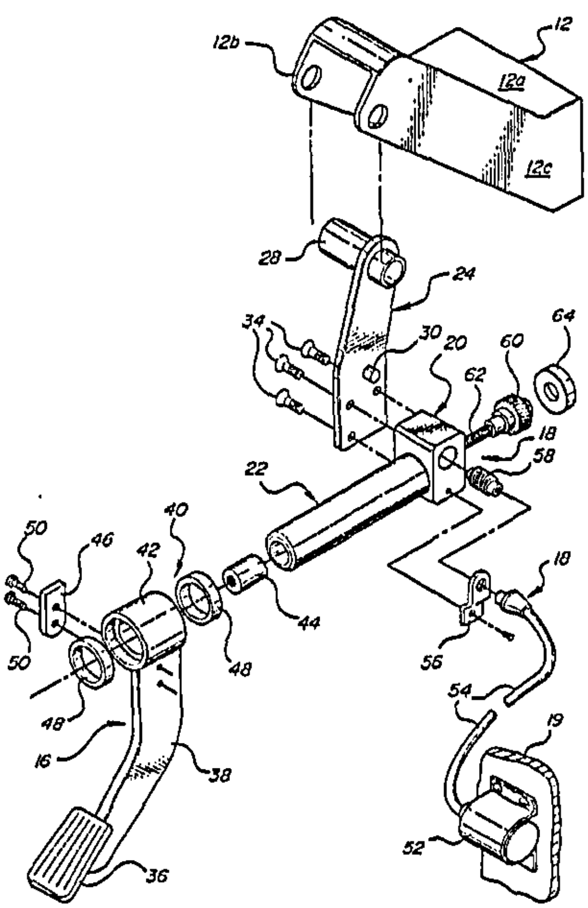
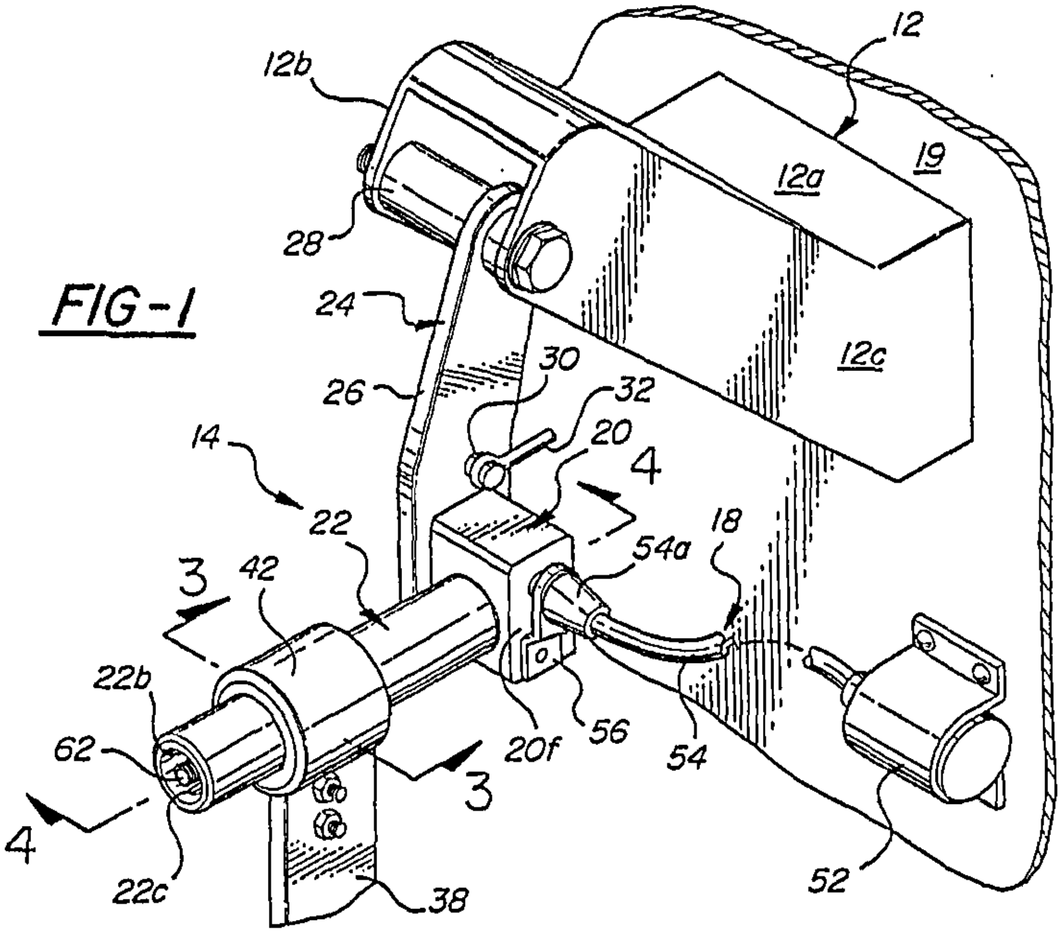


FIG-1



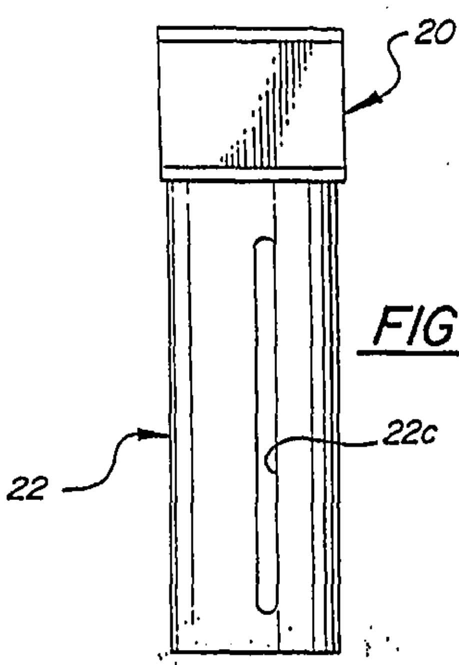


FIG-5

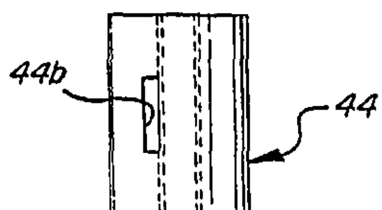


FIG-6

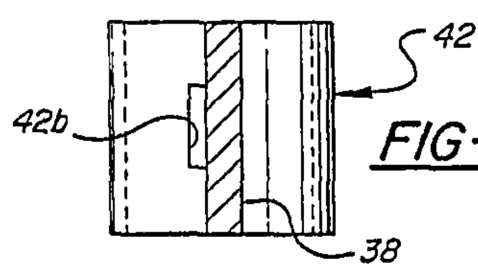
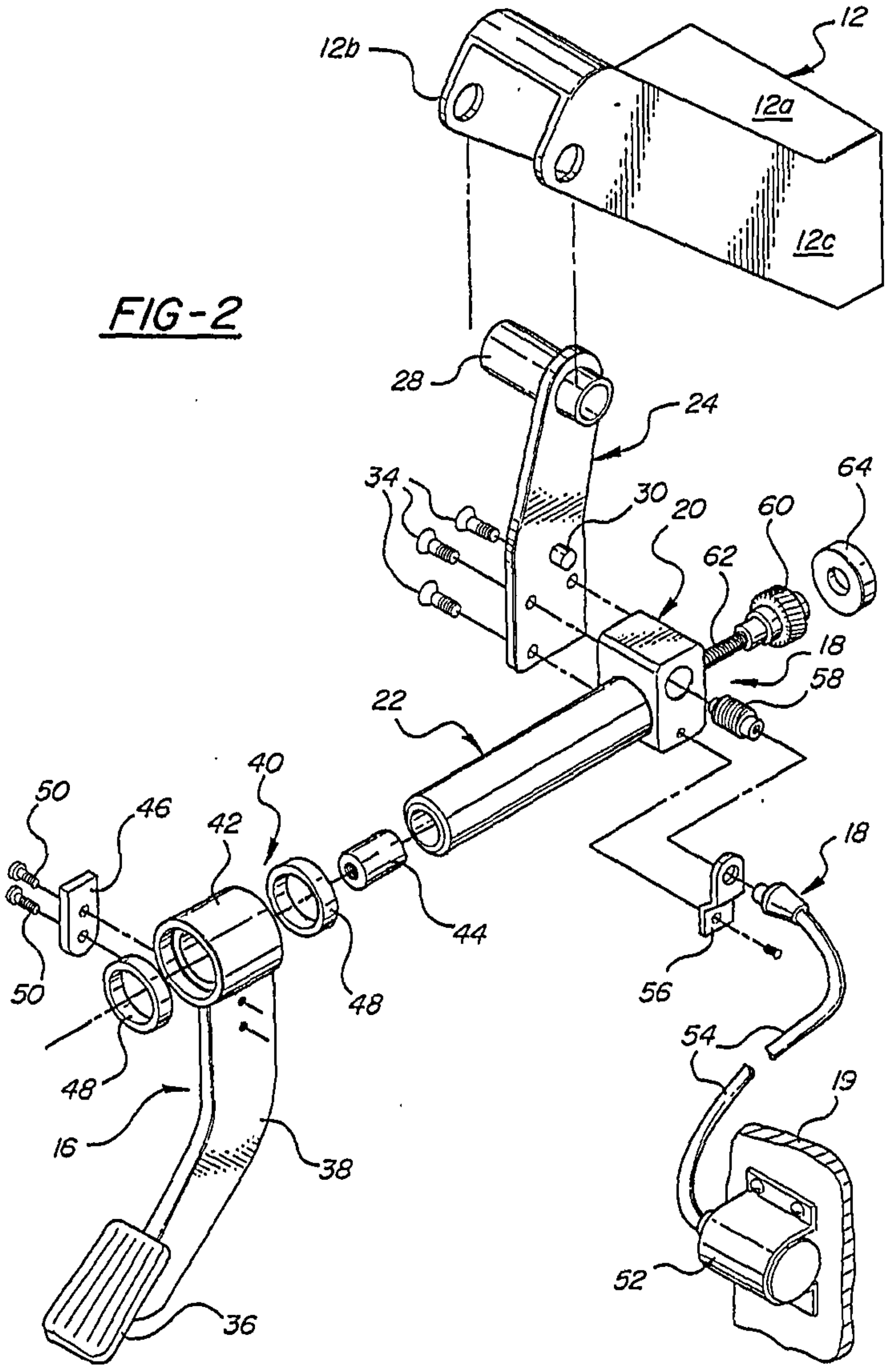


FIG-7

FIG-2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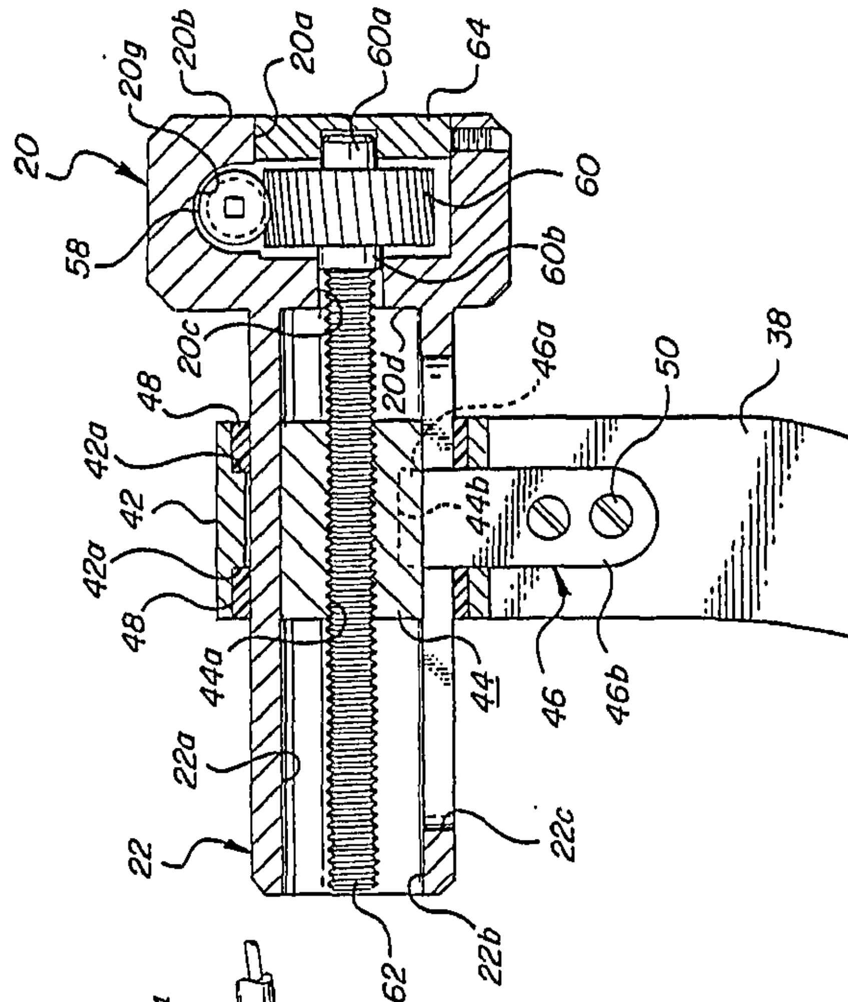
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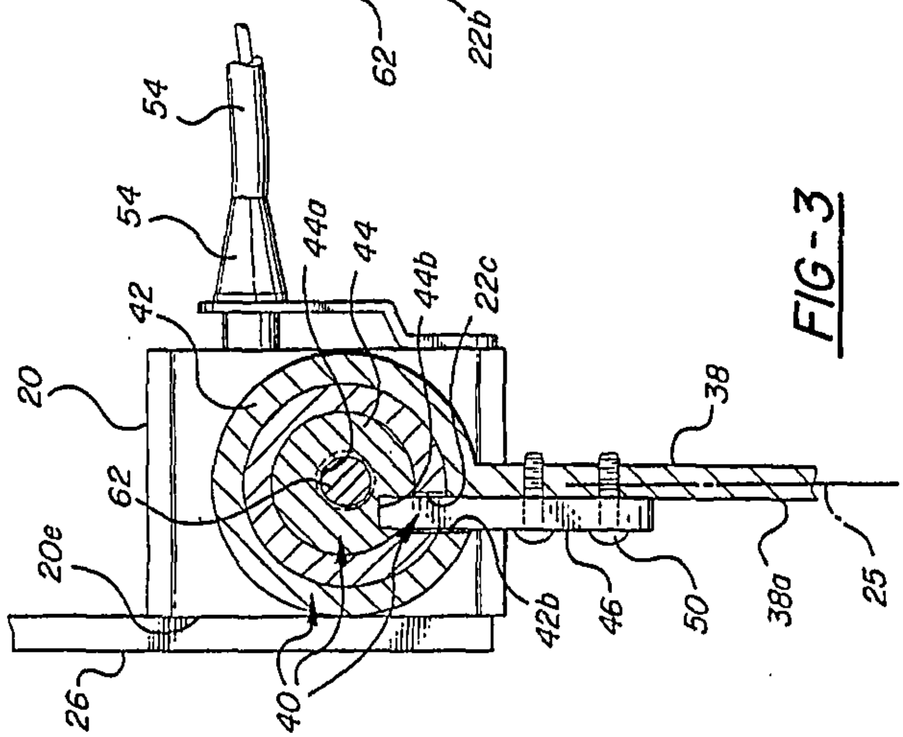
FIG-4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20e
42b
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FIG-3

ADJUSTABLE PEDAL ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to control pedal apparatuses and more particularly to adjustment means for selectively adjusting the position of one or more of the control pedals of a motor vehicle.

In a conventional automotive vehicle pedals are provided for controlling brakes and engine throttle. If the vehicle has a manual transmission a clutch pedal is also provided. These pedals are foot operated by the driver. In order for the driver to maintain the most advantageous position for working these control pedals the vehicle front seat is usually slidably mounted on a seat track with means for securing the seat along the track in a plurality of adjustment positions.

The adjustment provided by moving the seat along the seat track does not accommodate all vehicle operators due to differences in anatomical dimensions. Further, there is growing concern that the use of seat tracks, and especially long seat tracks, constitutes a safety hazard in that the seat may pull loose from the track during an accident with resultant injuries to the driver and/or passengers. Further, the use of seat tracks to adjust the seat position has the effect of positioning shorter operators extremely close to the steering wheel where they are susceptible in an accident to injury from the steering wheel or from an exploding air bag. It is therefore desirable to either eliminate the seat track entirely or shorten the seat track to an extent that it will be strong enough to retain the seat during an impact. Shortening or eliminating the seat track requires that means be provided to selectively move the various control pedals to accommodate various size drivers.

Various proposals were made over a period of many years to provide selective adjustment of the pedal positions to accommodate various size drivers but none of these proposals met with any significant commercial acceptance since the proposed mechanisms were unduly complex and expensive and/or were extremely difficult to operate and/or accomplished the required pedal adjustment only at the expense of altering other critical dimensional relationship as between the driver and the various pedals. Recently a control pedal mechanism has been developed which is simple and inexpensive and easy to operate and that accomplishes the required pedal adjustment without altering further critical dimensional relationships as between the driver and the various pedals. This control pedal mechanism is disclosed in U.S. Pat. Nos. 4,875,385; 4,989,474 and 5,078,024 all assigned to the assignee of the present application. The present invention represents improvements to the basic adjustable control pedal design disclosed in these patents.

SUMMARY OF THE INVENTION

This invention is directed to the provision of a simple, inexpensive and effective apparatus for adjusting the control pedals of a motor vehicle.

This invention adjustable pedal apparatus is intended for use with any of the control pedals of a motor vehicle and provides a simple and effective means of adjusting the position of the pedal to match the particular anatomical dimension of the operator.

The invention pedal apparatus includes a pedal support structure including a forward mounting structure and a guide rod extending rearwardly and rigidly from the mounting structure; a screw shaft extending proximate to and parallel to the guide rod; drive means for driving the screw shaft; and a pedal structure including an upper guide structure, defining a smooth guide bore slidably receiving the guide rod and a threaded bore threadably receiving the screw shaft, and a

pedal arm extending downwardly from the upper guide structure. This arrangement provides a simple and effective means for readily adjusting the position of the pedal structure.

According to a further feature of the invention, the guide rod is hollow; the screw shaft is positioned concentrically within the hollow of the guide rod; and the upper guide structure of the pedal structure includes an outer hub structure slidably mounted on the guide rod, a nut positioned slidably within the hollow of the guide rod and threadably receiving the screw shaft, and drive means drivingly interconnecting the structure and the nut. This specific packaging arrangement as between the pedal structure, screw shaft and guide rod provides a compact and simple apparatus for readily adjusting the pedal position.

According to a further feature of the invention, an elongated slot is provided in the hollow guide rod structure and the drive means comprises a key secured at one end thereof to the nut, passing through the slot, and interconnecting the nut and the pedal structure. This specific driving arrangement as between the nut and the pedal structure provides a simple and effective drive package.

According to a further feature of the invention, the forward mounting structure includes a transmission housing rearwardly of the guide rod; the drive means includes a transmission positioned in the transmission housing and including a first transmission member driving the screw shaft and a second transmission member driving the first transmission member, and the drive means further includes a cable driving the second transmission member. This specific arrangement provides a simple and efficient means for providing the power for moving the pedal structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective fragmentary view of the invention adjustable pedal assembly;

FIG. 2 is an exploded view of the pedal assembly;

FIGS. 3 and 4 are cross-sectional views taken respectively on lines 3—3 and 4—4 of FIG. 1; and

FIGS. 5, 6 and 7 are detail bottom views of individual components of the pedal assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention control pedal apparatus, broadly considered, includes a mounting bracket **12**, a pedal support assembly **14**, a pedal assembly **16**, and a drive assembly **18**.

Mounting bracket **12** may be formed of any suitable sheet metal material in a suitable stamping operation and is intended for suitable securement to the firewall **19** of the associated motor vehicle. Bracket **12** includes a top wall **12*a*** and laterally spaced side walls **12*b*** and **12*c***.

Pedal support assembly **14** includes a transmission housing **20**, a circular guide rod **22**, and a pivot arm **24**. Transmission housing **20** and guide rod **22** may be formed as separate items but preferably, as shown, are formed as a single forged piece.

Transmission housing **20** has a generally cubical configuration and defines a hollow **20*a*** opening at the front face **20*b*** of the housing and a central bore **20*c*** defined in a rear wall **20*d*** of the housing.

Guide rod **22** extends rigidly rearwardly from the rear wall **20*d*** of the transmission housing **20**, is hollow so as to provide a tubular configuration defining a central bore **22*a*** concentric with bore **20*c***, is open at its rear end **22*b***, and includes a bottom axial slot **22*c*** extending from a location proximate transmission wall **20*d*** to a location proximate rod rear end **22*b***. Slot **22*c*** is offset relative to the central vertical axis **25** of the apparatus.

Pivot arm 24 includes an elongated plate 26, a pivot pin 28 fixedly secured to the upper end of the plate 26 and suitably pivotally mounted proximate the rear end of bracket 12 in bracket side walls 12*b* and 12*c*, and a control pin 30 fixedly secured to plate 24 and adapted to pivotally receive one end of a control rod 32 controlling, for example, the brake mechanism of the motor vehicle. The lower end of plate 24 is fixedly secured as by fasteners 34 to a side face 20*e* of transmission housing 20.

Pedal assembly 16 includes a pedal 36, a pedal arm 38 carrying the pedal 36 at its lower end, and an upper guide structure 40.

Upper guide structure 40 includes a hub structure 42, a nut 44 and a key 46.

Hub structure 42 is fixedly secured to the upper end of pedal arm 38 and is sized to be slidably mounted on guide rod 22 with the aid of bushings 48 positioned in suitable annular recesses 42*a* proximate the forward and rearward annular edges of the hub structure. Hub structure 42 and bushings 48 will be seen to coact to define a smooth guide bore slidably receiving guide rod 22 whereby to enable the pedal assembly to move smoothly axially forwardly and rearwardly with respect to the guide rod.

Nut 44 may be formed of plastic, has a circular cross-sectional configuration, is sized to fit slidably within the bore 22*a* of the guide rod, and includes a threaded central bore 44*a*.

Key 46 has an elongated plate configuration and is fixedly secured at its upper end 46*a* in a keyway 44*b* provided in the lower face of nut 44 in offset relation to the central vertical axis 25 of the apparatus. Key 46 passes downwardly through elongated axial slot 22*c* in the lower side of the guide rod and through an aperture 42*b* in the hub structure 42 for securement at its lower end 46*b*, utilizing fasteners 50, to side face 38*a* of pedal arm 38.

Drive assembly 18 includes a motor 52, a cable 54, a bracket 56, a worm 58, a worm wheel 60, and a screw shaft 62.

Motor 52 comprises a small electric motor of known form and may be secured, for example, to firewall 19. Cable 54 is driven by the output shaft of motor 52 and is mounted at its distal end 54*a* on a bracket 56 secured to side face 20*f* of transmission housing 20. Cable 54 drives a worm 58 journalled in a cross bore 20*g* in transmission housing 20 in overlying relation to housing cavity 20*a*. Worm 58 is in driving engagement with worm wheel 60 positioned in cavity 20*a*.

Worm wheel 6o includes a front trunion 60*a* journalled in a bushing 64 fixedly positioned in the open forward end of cavity 20*a* and a rear trunion 60*b* journalled in a counterbore 20*g* of bore 20*c*. Screw shaft 62 is fixedly secured to worm wheel 60 and extends rearwardly therefrom through bore 20*c* and rearwardly through guide rod bore 20*a* for threaded engagement with the threaded central bore 44*a* of nut 44 so that rotation of shaft 62 has the effect of sliding nut 44 forwardly and rearwardly within bore 22*a*.

To assembly the invention apparatus, pivot pin 28 is suitably mounted in bracket 12, the lower end of plate 26 is fixedly secured to transmission housing 20, nut 44 is positioned within bore 22*a* in threaded engagement with screw 62, and hub structure 42 is positioned in surrounding relation to guide rod 22. With pedal arm 38 extending downwardly so as to align aperture 42*b* with slot 22*c*, nut 44 is suitably adjusted angularly within bore 22*a* to align keyway 44*b* angularly with respect to slot 22*c* and aperture 42*b*, hub structure 42 is adjusted axially to align aperture 42*b* axially with keyway 44*b*, and key 46 is slid upwardly through aperture 42*b* and through slot 22*c* for seating engagement in keyway 44*b*, whereafter the key is fixedly secured at its lower end 46*b* to side face 38*a* of pedal arm 38 utilizing fasteners 50. The apparatus is now ready for installation in a motor vehicle.

Installation in a motor vehicle is accomplished simply by securing the bracket 12 and the motor 52 to the firewall 19 of the vehicle and coupling control rod 32 to control panel 30.

In operation, the position of the pedal 36 relative to the operator is selectively adjusted by selectively energizing motor 52 to selectively move nut 44 forwardly and rearwardly within guide rod bore 22*a* and thereby, via the key 46, move the pedal assembly selectively forwardly and rearwardly along the guide rod with the limits of forward and rearward movement determined by engagement of the key with the respective forward and rearward ends of the slot 22*c*.

The invention will be seen to provide an adjustable pedal apparatus that is extremely simple in structure, extremely reliable, extremely inexpensive, and capable of precisely adjusting the position of the pedal so as to accommodate operators of varying anatomical dimensions.

Whereas a preferred embodiment of the invention has been illustrated and described in detail it will be apparent that various changes may be made in the disclosed embodiment without departing from the scope or spirit of the invention. For example, although the invention has been illustrated and described with respect to an adjustable apparatus in which no provision is made to provide constant ratio adjustment, and constant pedal loads, in all adjusted positions of the pedal, the invention is equally applicable to an adjustable apparatus, such for example as the apparatuses shown in assignee's U.S. Pat. Nos. 4,875,385; 4,989,474 and 5,078,024, in which provision is made to provide constant ratio adjustment and constant pedal force irrespective of pedal position. Further, although the invention as disclosed contemplates that each individual operator will adjust the pedals to suit his own stature each time he enters the vehicle after the vehicle has been operated by another operator, the motor of the pedal assembly may be equipped with a memory facility whereby an operator may effect movement of the pedal assembly to his own unique position simply by suitably announcing his presence in the vehicle and allowing the memory to automatically move the pedal assembly to his own unique position.

We claim:

1. An adjustable pedal apparatus for a motor vehicle comprising:

a pedal support assembly including a forward mounting structure and a hollow guide rod extending rearwardly and rigidly from the mounting structure;

a screw shaft positioned within the hollow of the guide rod and extending parallel to said guide rod;

drive means for driving the screw shaft; and

a pedal assembly including a hub structure defining a smooth guide bore slidably receiving said guide rod, a nut positioned within the hollow rod and defining a threaded bore threadably receiving said screw shaft, a pedal arm extending downwardly from said hub structure, and means drivingly interconnecting the nut and the hub structure whereby rotation of the screw shaft moves the nut within the hollow rod and the drive means translates the nut movement into movement of the hub structure and the pedal arm.

2. An apparatus according to claim 1 wherein:

the apparatus further includes a mounting bracket; and

the forward mounting structure is pivotally secured to the mounting bracket.

3. An apparatus according to claim 1 wherein:

the guide rod and the guide bore have a circular cross sectional configuration.

4. An apparatus according to claim 1 wherein:

an elongated slot is provided in the hollow guide rod; and

the interconnecting means comprises rigid structure passing through the slot and rigidly interconnecting the nut and the hub structure.

5. An apparatus according to claim 1 wherein:

the forward mounting structure includes a transmission housing forwardly of the guide rod;

the drive means includes a transmission positioned in the transmission housing and including a first transmission member driving the screw shaft and a second transmission member driving the first transmission member; and

the drive means further includes a cable driving the second transmission member.

6. An apparatus according to claim 5 wherein the drive means further includes an electric motor driving the cable.

7. An apparatus according to claim 5 wherein:

the pedal support assembly further includes a mounting bracket; and

the forward mounting structure further includes a pivot arm fixed to the transmission housing and pivotally mounted on the mounting bracket.

8. An adjustable pedal apparatus for a motor vehicle comprising:

a mounting bracket;

a hollow guide rod;

means pivotally mounting the guide rod on the mounting bracket with the guide rod extending rearwardly;

a pedal structure including an upper hub structure slidably mounted on the guide rod and a pedal arm extending downwardly from the hub structure;

a nut positioned slidably in the hollow of the guide rod;

a screw positioned within the guide rod and threadably engaging the nut;

drive means interconnecting the nut and the pedal structure; and

means for rotating the screw.

9. A pedal apparatus according to claim 8 wherein the rotating means are positioned forwardly of the screw.

10. A pedal apparatus according to claim 8 wherein:

the guide rod includes an elongated axial slot; and

the drive means includes a key fixed to the nut and passing through the elongated slot for securement to the pedal structure.

11. A pedal apparatus according to claim 8 wherein:

the apparatus includes a housing positioned forwardly of the guide rod; and

the rotating means includes transmission means positioned in the housing and including a first transmission member driving the screw and a second transmission member driving the first transmission member.

12. A pedal apparatus according to claim 11 wherein:

the rotating means further includes an electric motor and a cable driven by the electric motor and driving the second transmission member.

13. An adjustable pedal apparatus for a motor vehicle comprising:

a pedal support assembly including a forward mounting structure and a hollow guide rod extending rearwardly and rigidly from the mounting structure and including an elongated slot;

a screw shaft positioned concentrically within the hollow of the guide rod and extending proximate and parallel to the guide rod;

drive means for driving the screw shaft; and

a pedal assembly including an upper guide structure and a pedal arm extending downwardly from said upper guide structure;

the upper guide structure including an outer hub structure slidably mounted on the guide rod and including an aperture, a nut positioned slidably within the hollow of the guide rod and threadably receiving the screw shaft, and means drivingly interconnecting the pedal assembly and the nut;

the interconnecting means comprising a key secured at one end thereof to the nut, passing through the slot in the rod and through the aperture in the hub structure, and secured at its other end to the pedal arm.

14. An adjustable pedal apparatus for a motor vehicle comprising:

a mounting bracket;

a hollow guide rod including an elongated axial slot;

means pivotally mounting the guide rod on the mounting bracket with the guide rod extending rearward;

a pedal structure including an upper hub structure slidably mounted on the guide rod and including an aperture and a pedal arm extending downwardly from the hub structure;

a nut positioned slidably in the hollow of the guide rod;

a screw positioned within the guide rod and threadably engaging the nut;

means for rotating the screw; and

a key fixed to the nut and passing through the elongated slot and through the aperture for securement to the pedal structure.

15. An adjustable pedal apparatus for a motor vehicle comprising:

a pedal support assembly including a forward mounting structure and a hollow guide rod extending rearwardly and rigidly from the mounting structure;

a screw shaft positioned within the hollow of the guide rod and extending parallel to the guide rod;

drive means for driving the screw shaft; and

a pedal assembly including an upper guide structure defining a smooth guide bore slidably receiving said guide rod, a nut positioned within the hollow rod and defining a threaded bore threadably receiving said screw shaft, a pedal arm extending downwardly from said upper guide structure, and means drivingly interconnecting the nut and the guide structure whereby rotation of the screw shaft moves the nut within the hollow rod and the drive means translates the nut movement into movement of the guide structure and the pedal arm.

* * * * *

United States Patent [19] | [11] Patent Number: 4,915,075
Brown | [45] Date of Patent: Apr. 10, 1990

[54] ACCELERATOR PEDAL POSITION SENSOR

[75] Inventor: Richard L. Brown, Pekin, Ill.

[73] Assignee: Caterpillar Inc., Peoria, Ill.

[21] Appl. No.: 326,129

[22] Filed: Mar. 20, 1989

[51] Int. Cl.[4] F02D 11/10; H01C 10/00

[52] U.S. Cl. 123/399; 73/118.1; 74/513; 123/494; 338/153

[58] Field of Search 123/357, 361, 399, 494; 73/118.1; 324/208; 340/870.38; 338/108, 153; 74/513

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Primary Examiner—Tony M. Argenbright
Attorney, Agent, or Firm—Robert E. Muir; Stephen L. Noe; Kirk Vander Leest

[57] ABSTRACT

Pedal mounted sensors are useful in motor vehicles for delivering an electrical signal correlative to the position of the accelerator pedal. The electrical signal is then used by an engine controller to regulate the amount of fuel supplied to the engine. Some pedal mounted sensors deliver analog signals which are subject to fault conditions which an engine controller can not distinguish from valid operating conditions. Remotely mounted sensors are difficult to install and repair. The subject invention is directed to pedal mounted sensors which have a potentiometer and circuit board hermetically sealed and mounted on a pedal for delivering pulse-width-modulated signal having a duty factor responsive to the pedal position.

7 Claims, 3 Drawing Sheets

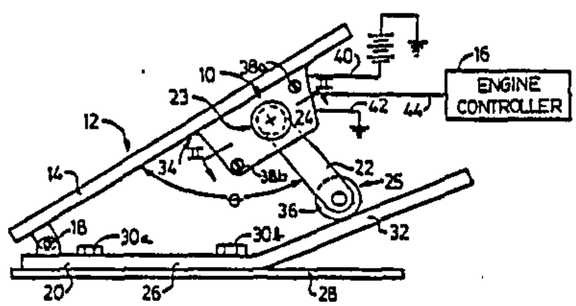
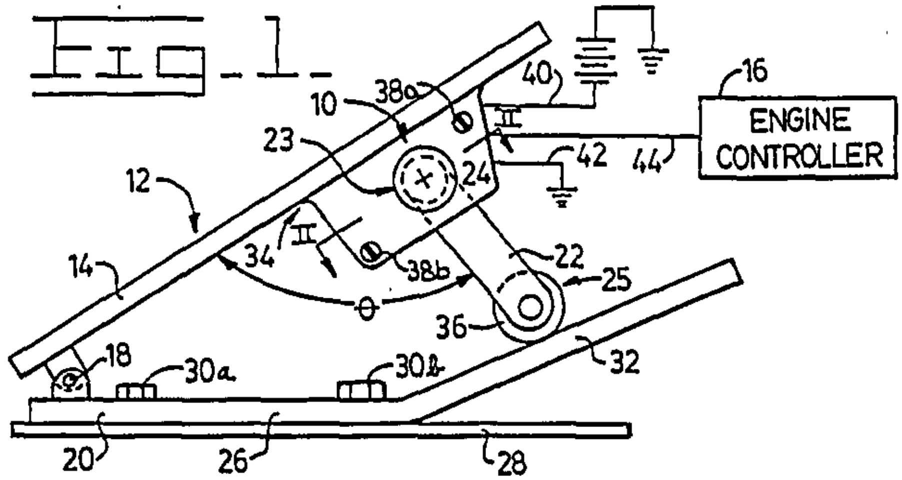
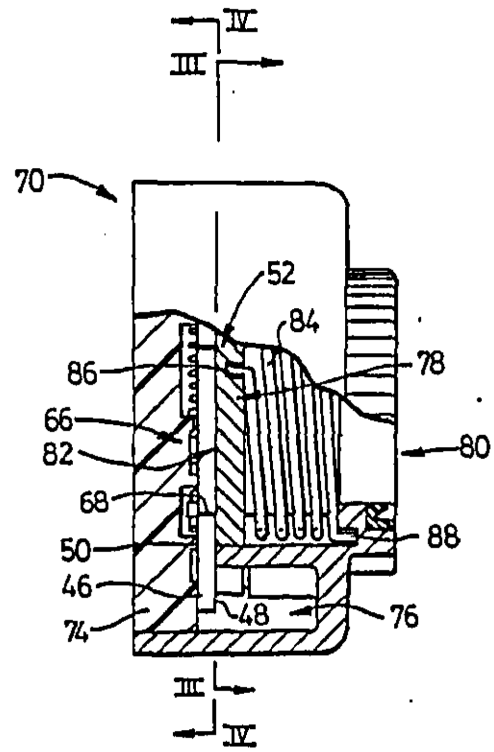


Fig. 1



ENGINE CONTROLLER
10
12
14
16
18
20
22
23
24
25
26
28
30a
30b
32
34
36
38a
38b
40
42
44
θ
II

Fig. 2



III
IV
70
52
84
78
86
66
82
68
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46
74
48
76
80
88

Fig. 3.

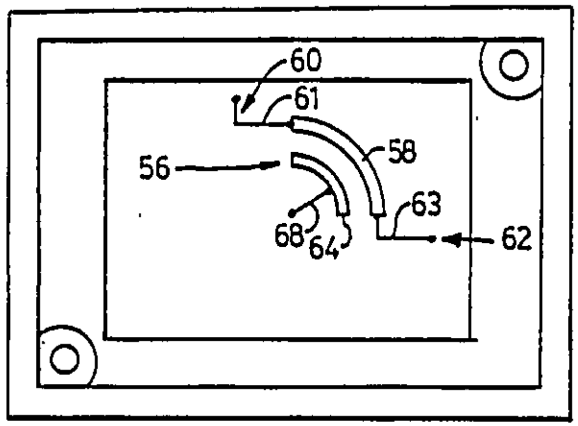
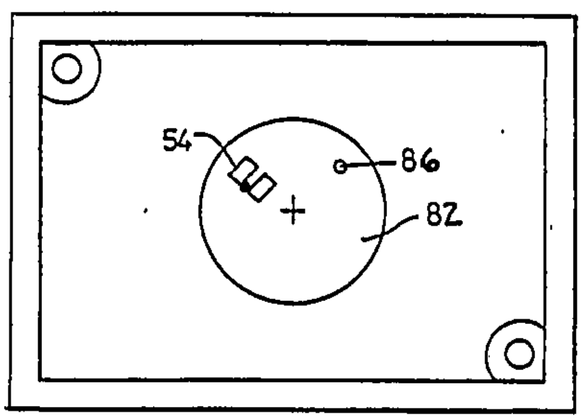


Fig. 4.



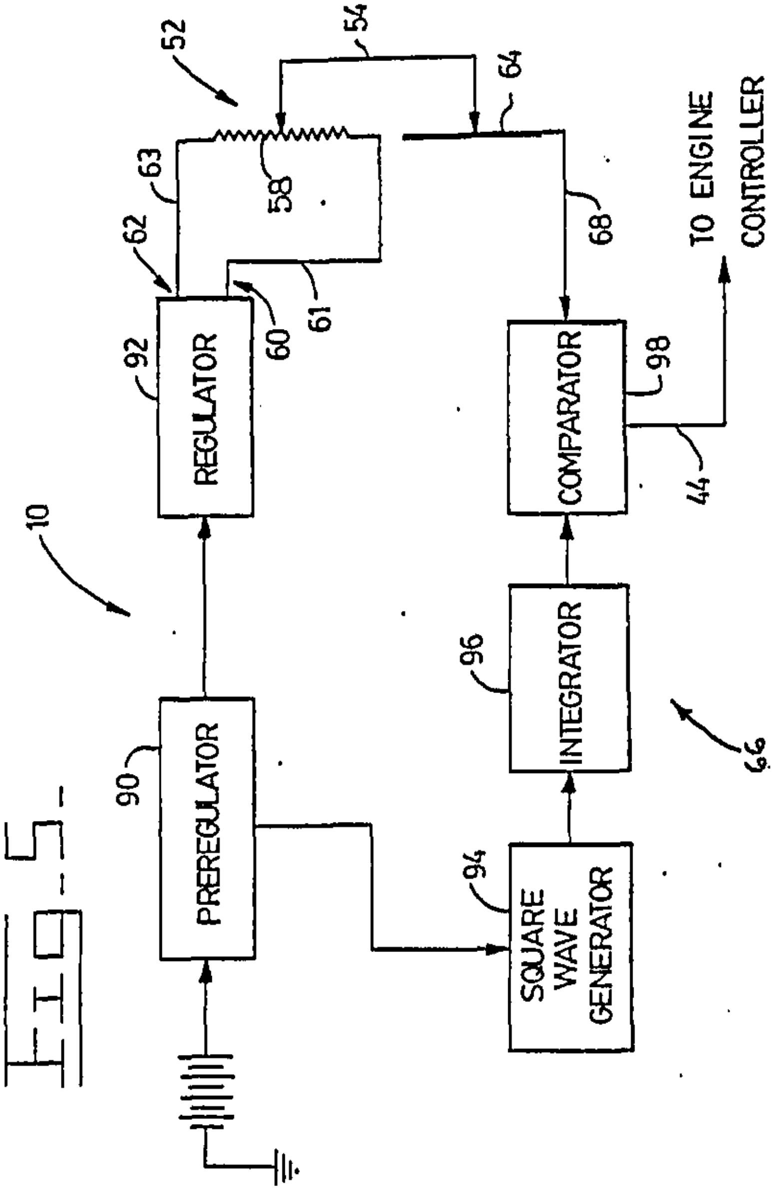

52
54
64
63
58
62
68
TO ENGINE CONTROLLER
61
60
92
REGULATOR
COMPARATOR
98
44
10
96
INTEGRATOR
66
90
PREREGULATOR
94
SQUARE WAVE GENERATOR

FIG_5_

ACCELERATOR PEDAL POSITION SENSOR

DESCRIPTION

1. Technical Field

The present invention relates generally to a system for detecting the position of a control pedal and producing an electrical signal in responsive to the position of the control pedal and, more particularly, to a system for detecting the position of an accelerator pedal of a work vehicle and producing a pulse-width-modulated signal correlative to a desired engine speed.

2. Background Art

In the past, the most common means of communicating a desired engine speed to an engine has been a mechanical linkage from the accelerator pedal to the engine throttle valve. However, modern engines are equipped with electronic engine controllers and it is desirable to replace the mechanical linkage with an electronic equivalent. More particularly, it is desirable to provide a pedal position sensor for delivering an electrical signal which is responsive to the position of the pedal.

It is common in the art to utilize a a pedal mounted potentiometer to produce an analog signal in response to the position of an accelerator pedal. The engine controller receives the analog signal and calculates a desired engine speed based on an empirical derived relationship. In order to eliminate unnecessary mechanical devices, it is preferable to mount the sensor directly on the pedal. In such a location, the potentiometer is subject to a variety of extreme conditions including serious vibration, dust, etc. Therefore, it is possible for a fragile electrical device, such as a potentiometer, to malfunction and produce a signal which is not indicative of the actual pedal position.

U.S. Pat. No. 4,519,360 which issued on May 28, 1985 to Murakami and U.S. Pat. No. 4,603,675 which issued on Aug. 5, 1986 to Junigiger et al. provide systems for detecting when a potentiometer adapted to sense pedal position is malfunctioning. More specifically, both systems indicate when the engine throttle remains open even though the accelerator pedal is fully released. In order to perform this function, both systems require an extra sensor for detecting when the accelerator pedal is fully released. However, even these systems are further subject to inaccuracies induced by electromagnetic interference and wiring harness degradation.

More particularly, electromagnetic interference can interfere with the analog signal produced by the potentiometer thereby providing an inaccurate signal to the engine controller. The greater the distance between the pedal mounted potentiometer and the engine controller, the more likely it is that interference will affect the analog signal. Filters in the engine controller can be used to remove electromagnetic interference from an oscillating portion of the analog signal; however, filters cannot correct for any change in a DC voltage offset induced by the electromagnetic interference. The engine controller can not be programmed to distinguish between a DC offset caused by electromagnetic interference and one correctly representing the accelerator pedal position.

In addition, the above mentioned extreme conditions can also lead to a degradation of the wiring harness used to connect the potentiometer to the engine controller. For example, moisture can induce conductivity between individual wires in the wiring harness, and over

time the resistance of individual wires in the wiring harness can change. This wiring harness degradation can induce inaccuracies in the signal received by the engine controller similar to those caused by electromagnetic interference.

Other systems currently address the above mentioned problems by combining a pedal sensing potentiometer and a conditioning circuit in a single signal generating apparatus. The conditioning circuit modifies the analog signal delivered by the potentiometer and produces a pulse-width-modulated signal in response to the accelerator pedal position. Due to the close proximity of the potentiometer and the conditioning circuit, the effects of electromagnetic interference on the analog signal delivered to the conditioning circuit are negligible. Furthermore, the engine controller can be programmed to recognize invalid waveforms in the pulse-width-modulated signal which are caused by electromagnetic interference and wiring harness degradation.

To date, signal generating units having both a potentiometer and conditioning circuit in a single unit are not pedal mounted. Therefore, a mechanical linkage is used to connect the accelerator pedal to the signal generating apparatus. Due to the unit's remote location, installation and maintenance are made difficult, expense is incurred, and a mechanical linkage is once more required by such systems.

The present invention is directed to addressing the above mentioned problems with an apparatus that can be easily mounted directly on an accelerator pedal. Other aspects, objects and advantages can be obtained from a study of the drawings, the disclosure, and the appended claims. While the present invention is described for use with an accelerator pedal it is recognized that such an apparatus could be adapted for use with numerous other control pedals.

DISCLOSURE OF THE INVENTION

In accordance with one aspect of the present invention, there is provided a signal generating apparatus for delivering a pulse-width-modulated signal responsive to the position of a movable mechanical member. A circuit board has a potentiometer mounted on a first side and a conditioning circuit mounted on a second side. The potentiometer has a movable wiper portion in movable contact with a stationary portion. The movable wiper is further connected to and movable with the movable mechanical member. The conditioning circuit is electrically connected to the stationary portion so that the conditioning circuit produces the pulse-width-modulated signal in response to the position of the movable wiper on the stationary portion.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side view of a pedal mounted sensor adapted to deliver a signal in response to the position of the pedal.

FIG. 2 is a diagrammatic sectional partial view taken along line II—II of FIG. 1.

FIG. 3 is a diagrammatic sectional partial view taken along line III—III of FIG. 2.

FIG. 4 is a diagrammatic sectional partial view taken along line IV—IV of FIG. 2.

FIG. 5 is a functional block diagram of an embodiment of the pedal mounted position sensor of FIG. 1.

BEST MODE FOR CARRYING OUT THE INVENTION

FIG. 1 illustrates the relationship between an accelerator pedal unit 12 of a work vehicle (not shown) and a signal generating apparatus 10. The signal generating apparatus 10 produces a pulse-width-modulated signal having a duty factor responsive to the position of the pedal 14, and delivers the signal to an engine controller 16. The pedal 14 is illustrative and the signal generating apparatus 10 can be adapted for use with other movable mechanical members. In a preferred embodiment the accelerator pedal unit 12 is a series WM-516 manufactured by Williams Precision Controls of Portland, Oreg., and includes the pedal 14, a hinge 18, a baseplate 20, a lever 22, and a pin 24. The base plate 20 has a horizontal portion 26 rigidly attached to the vehicle frame 28 by anchor bolts 30*a*–30*c*, for example. The base plate 20 further includes an angled portion 32 which is fixed relative to the vehicle frame 28. The pedal 14 is pivotally movable about the hinge 18 relative to the work vehicle frame 28. Preferably the hinge 18 can be positioned on the base plate horizontal portion 26 as shown; however, the hinge 18 can also be rigidly attached to the vehicle frame 28.

The pedal 14 is movable between a first position corresponding to engine idle speed and a second position corresponding to maximum engine speed. A pedal return spring (not shown) biases the pedal 14 to the first position. The pin 24 is positioned on the pedal lower portion 34 and is rotatable relative to and in response to pivotal movement of the pedal 14 by the lever 22. The lever 22 has first and second end portions 23,25. The lever first end portion 23 is fixedly connected to the pin 24 and the lever second end portion 25 includes a roller 36 in contact with and movable along the base plate angled portion 32 in response to movement of the pedal 14.

In a preferred embodiment, a pair of connecting bolts 38*a*,38*b* are used to attach the signal generating apparatus 10 to the pedal 14. However, it is foreseeable to accomplish this connecting function using adhesives or other fasteners. The signal generating apparatus 10 is electrically connected to a source of positive battery voltage, to ground, and to the engine controller 16 by respective wires 40, 42, and 44.

Referring now to FIGS. 2, 3, and 4, a circuit board 46 has first and second sides 48,50. A rotatable potentiometer 52 has a movable wiper 54 in movable contact with a stationary portion 56. The potentiometer is positioned on the circuit board first side 48, and delivers a DC voltage in responsive to the position of the pedal 14 shown in FIG. 1. The potentiometer stationary portion 56 includes a resistive strip 58 and a conductive strip 64. The resistive strip is connected between a first voltage source 60 and a higher potential second voltage source 62 by respective wires 61 and 63. Preferably the resistive strip 58 and the conductive strip 64 are screen printed on the circuit board first side 48; however, it is foreseeable to position the strips 58,64 on the circuit board first side 48 using methods such as etching, insert molding, compression molding, etc. The movable wiper 54 is of negligible resistance and effectively forms a short circuit from the resistive strip 58 to the conductive strip 64. Thus, the entire conductive strip 64 is maintained at DC voltage potential correlative to the position of the movable wiper 54 on the resistive strip 58. One skilled in the art will recognize that the potentiometer 52 could be replaced, for example, by a variable capacitance or inductance device.

A conditioning circuit 66 is located on the circuit board second side 50 and is electrically connected to the conductive strip 64 by a wire 68. The conditioning circuit 66 receives the DC voltage delivered by the potentiometer 52 and delivers a pulse-width-modulated signal having a duty factor responsive to this DC voltage on the wire 44.

A housing 70 is of sufficient size to contain the conditioning circuit 66, the circuit board 46 and the potentiometer 52. In the preferred embodiment, the housing 70 is constructed of polyetherimide, but the housing 70 could be formed from numerous other materials. An epoxy resin 74 filling the void 76 between the housing 70 and the circuit board 46 hermetically seals the conditioning circuit 66, circuit board 46 and potentiometer 52 within the housing 70. The housing 70 and epoxy resin 74 support the circuitry and protect against possible malfunctions such as short circuits and broken wires within the signal generating apparatus 10.

The housing 70 includes a molded rotor 78 having a first end 80 integrally engaging and movable with the pin 24, shown in FIG. 1, and a second end 82 fixedly connected to the movable wiper 54. Thus, when the pin 24 rotates, the movable wiper 54 moves along the resistive strip 58 causing the potentiometer 52 to deliver a DC voltage correlative to the position of the pin 24. The molded rotor 78 can be constructed of any one of numerous nonconductive materials but is preferably polyetherimide. A return spring 84 has a first end 86 connected to the molded rotor second end 82 and a second end 88 connected to the housing 70, and is adapted to bias the molded rotor 78 to a preselected position.

Turning now to FIG. 4., a block diagram illustrates the functional aspects of the signal generating apparatus 10. These functional aspects are common in the industry; therefore, the exact circuitry will not be defined. A voltage preregulator 90 filters noise from and regulates the battery voltage to a level usable by the remaining electrical circuitry of the signal generating apparatus 10. In the preferred embodiment, battery voltage ranges from approximately +9 to +32 volts and the preregulator 90 delivers approximately a +10 volt signal. A voltage regulator 92 receives this preregulated voltage and delivers the first voltage potential on the wire 61 and the second voltage potential on the wire 63. In the preferred embodiment the first voltage source 60 is +0.7 volts and the second voltage source 62 is +5.7 volts; however, it is recognized that numerous other voltages may be chosen without departing from the invention. In the preferred embodiment, the voltage preregulator 90 and voltage regulator 92 are both located on the circuit board second side 48.

As previously stated, the resistive strip 58 is connected between the first and second voltage sources 60,62. The movable wiper 54 forms a short circuit from the resistive strip 58 to the conductive strip 64, causing the potentiometer 52 to deliver a DC voltage signal correlative to the position of the movable wiper 54 on the resistive strip 58. A wire 68 connects the conductive strip 64 to the conditioning circuit 66 such that the DC voltage signal delivered by the potentiometer 52 is received by the conditioning circuit 66.

In the preferred embodiment, the conditioning circuit 66 includes a square wave generator 94, an integrator 96, and a comparator 98. The square wave generator 94

receives the preregulated voltage from the voltage preregulator 90 and delivers a square wave signal having a predetermined amplitude and base frequency. The integrator 96 integrates this square wave signal and delivers a triangular wave signal having a predetermined amplitude and base frequency. In the preferred embodiment the triangular wave signal has an amplitude of +5 volts. The comparator 98 compares the triangular wave signal to the DC voltage signal produced by the potentiometer 52 and delivers a pulse-width-modulated signal having a duty factor responsive to the DC voltage signal. It is foreseeable that components other than those used in the preferred embodiment could be used for generating the pulse-width-modulated signal.

INDUSTRIAL APPLICABILITY

Assume that the signal generating apparatus 10 is mounted on the accelerator pedal of a work vehicle, not shown. Initially, the pedal 14 is biased to a predetermined position by a pedal return spring (not shown). At this predetermined position, an angle (theta) between the lever 22 and the pedal 14 is obtuse and the signal generating apparatus 10 produces a pulse-width-modulated signal having a duty factor representative of the initial pedal position. The engine controller 16 receives the pulse-width-modulated signal and calculates a desired engine speed based on the empirical relationship.

Subsequently, if a vehicle operator desires an increase in the engine speed the operator applies a force "F" to the accelerator pedal 14. As the operator applies the force "F", the pedal 14 rotates relative to the vehicle frame 28 about hinge 18 to a second position. As the pedal 14 is displaced from the first position to the second position, the lever 22 and pin 14 rotate relative to the pedal 14 in a preselected direction such that the angle (theta) increases in magnitude.

Rotation of the pin 24, causes the movable wiper 54 to rotate along the resistive strip 58 between first and second positions corresponding to the pedal first and second positions, respectively. The movable wiper 54 effectively forms a short circuit from the resistive strip 58 to the conductive strip 64; therefor, the entire conductive strip 64 has a DC voltage potential correlative to the position of the wiper 54 on the resistive strip 58. Thus, the potentiometer 52 delivers a DC voltage signal over the wire 68 responsive to the conductive strip voltage potential.

The conditioning circuit 66 receives the DC voltage signal from the potentiometer 52 and produces a pulse-width-modulated signal having a duty factor responsive to the DC voltage signal.

Because there is no appreciable distance between potentiometer 52 and the conditioning circuit 66, the effects of electromagnetic interference on the analog signal delivered to the conditioning circuit 66 are negligible. Additionally, in the event that electromagnetic interference or wiring harness degradation change the frequency or the DC level of pulse-width-modulated signals produced by the conditioning circuit 66, the engine controller 16 can be programmed to recognize invalid waveforms caused by such interference and wiring harness degradation.

The engine controller 16 receives the pulse-width-modulated signal and regulates the engines speed in response to the duty factor of the pulse-width-modulated signal. The engine controller 16 can be programmed to reduce the amount of fuel supplied to the engine to a preselected minimum in response to invalid waveforms in the pulse-width-modulated signal. For instance, if any of the wires 40,42,44 break, short, or become disconnected, a high signal is continuously delivered by the signal generating apparatus 10. The engine controller 16 in turn can be programmed to reduce the amount of fuel supplied to the engine to a preselected minimum upon receiving a continuous high signal for a predetermined period of time.

Other aspects, objects, and advantages of this invention can be obtained from a study of the drawings, the disclosure, and the appended claims.

I claim:

1. A signal generating apparatus for delivering a pulse-width-modulated signal responsive to the position of a movable mechanical member, comprising:

a circuit board having first and second sides;

a potentiometer having a movable wiper and a stationary portion, said movable wiper being in movable contact with said stationary portion, said movable wiper and said stationary portion being positioned on said circuit board first side and said movable wiper being connected to and movable with said movable mechanical member; and,

a conditioning circuit being positioned on said circuit board second side, electrically connected to said potentiometer stationary portion and adapted to deliver said pulse-width-modulated signal responsive to the position of said movable wiper on said potentiometer stationary portion.

2. The apparatus set forth in claim 1 wherein said potentiometer stationary portion includes:

a resistive strip connectable between a first voltage potential and a second voltage potential higher than said first voltage potential; and,

a conductive strip connected to said conditioning circuit.

3. The apparatus set forth in claim 2, wherein said movable wiper forms a short circuit from said resistive strip to said conductive strip at a position where said movable wiper contacts said resistive strip.

4. A signal generating apparatus for delivering a pulse-width-modulated signal responsive to the position of a pedal in a work vehicle, comprising:

a work vehicle frame;

a pedal having a pin, said pedal being pivotally movable relative to said work vehicle frame between first and second positions, said pin being positioned on said pedal and rotatable relative to said pedal in response to movement of said pedal relative to said work vehicle frame;

a circuit board having first and second sides;

a rotatable potentiometer having a rotatable wiper and a stationary portion, said rotatable wiper being in movable contact with said stationary portion, said rotatable wiper and said stationary portion being positioned on said circuit board first side, and said rotatable wiper being connected to and movable with said pin;

a conditioning circuit being positioned on said circuit board second side, electrically connected to said potentiometer stationary portion and adapted to deliver said pulse-width-modulated signal in response to the position of said movable wiper on said potentiometer stationary portion; and,

a means for rotating said pin in response to movement of said pedal.

5. The apparatus set forth in claim 4 including a housing of a size sufficient for containing said conditioning circuit, said potentiometer, and said circuit board; and,
   a means for hermetically sealing said conditioning circuit, said potentiometer, and said circuit board within said housing.

6. The apparatus set forth in claim 4 wherein said pin rotating means includes:
   a rigid base plate having an angled portion, said angled portion being fixed relative to said vehicle frame; and,
   a lever having first and second end portions, said lever first end portion being fixedly connected to said pin, and said lever second end portion having a roller in contact with and movable along said base plate angled portion in response to movement of said pedal.

7. The apparatus set forth in claim 5 wherein said housing includes:
   a molded rotor having first and second ends, said molded rotor first end integrally engaging said pin, said molded rotor second end being fixedly connected to said rotatable wiper; and,
   a return spring having first end connected to said molded rotor, a second end connected to said housing, and being adapted to bias said molded rotor to a preselected position.

* * * * *

United States Patent [19]

Lundberg

[11] Patent Number: **4,958,607**

[45] Date of Patent: **Sep. 25, 1990**

[54] FOOT PEDAL ARRANGEMENT FOR ELECTRONIC THROTTLE CONTROL OF TRUCK ENGINES

[75] Inventor: Chester E. Lundberg, Sherwood, Oreg.

[73] Assignee: Williams Controls, Inc., Portland, Oreg.

[21] Appl. No.: 340,234

[22] Filed: Apr. 18, 1989

[51] Int. Cl.[5] F02D 11/10; G05G 1/14

[52] U.S. Cl. 123/399; 74/513; 180/335

[58] Field of Search 123/361, 399; 74/513, 74/560; 180/335

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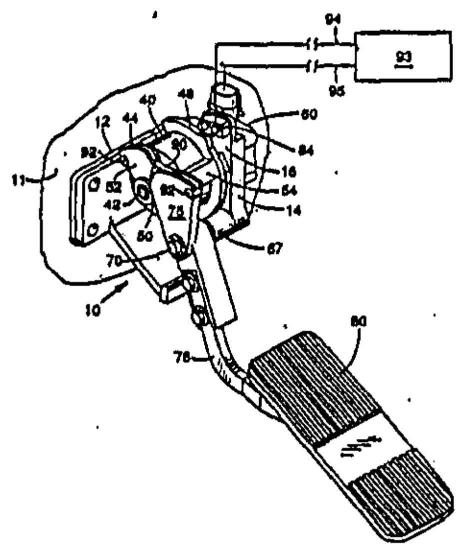
Primary Examiner—Willis R. Wolfe
Attorney, Agent, or Firm—Robert L. Harrington

[57] ABSTRACT

A foot pedal arrangement wherein a support structure is mounted to the front wall of a diesel powered truck cab. A spring biased spool is mounted to the support structure and is interconnected to a potentiometer. A foot pedal includes a projecting arm that is pivoted to the support structure. A flexible link connection between the foot pedal arm and the spool forces rotation of the spool with pivoting of the pedal. The connection is designed to translate the traditional pedal movement to the required spool rotation as needed for monitoring by the potentiometer.

8 Claims, 3 Drawing Sheets



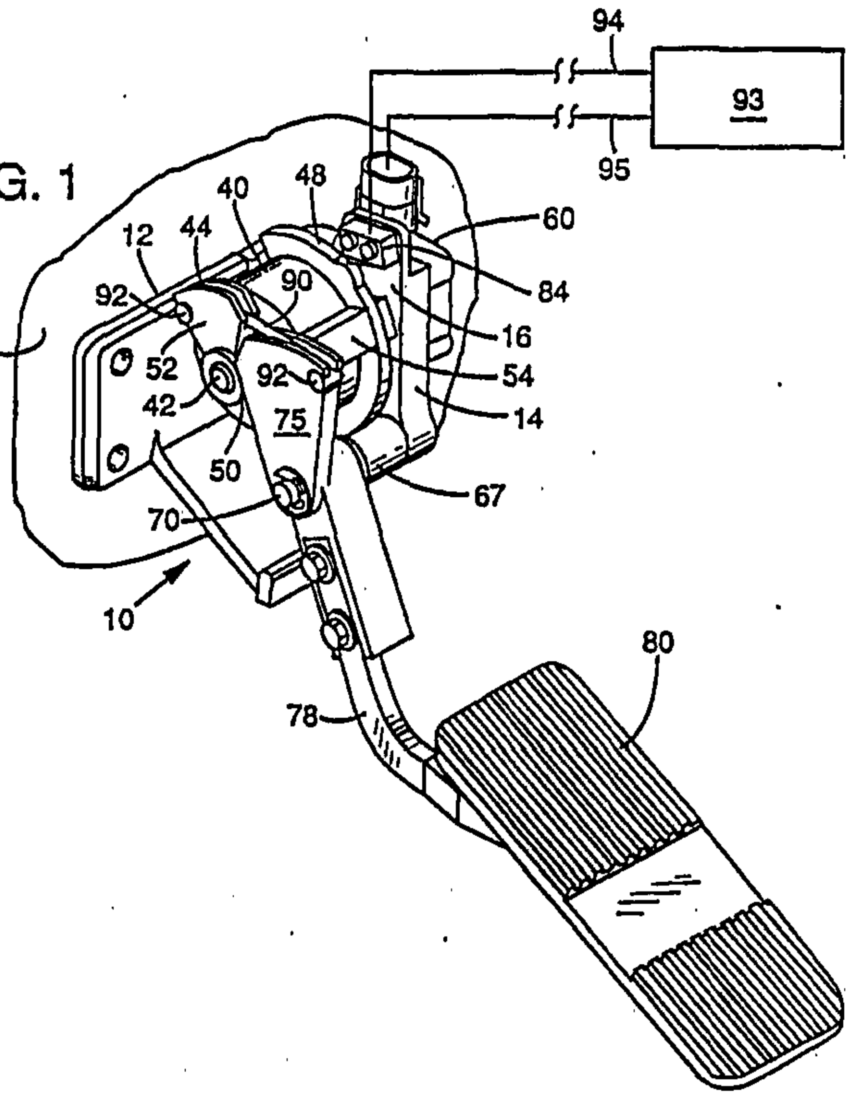

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FIG. 1

FIG. 2

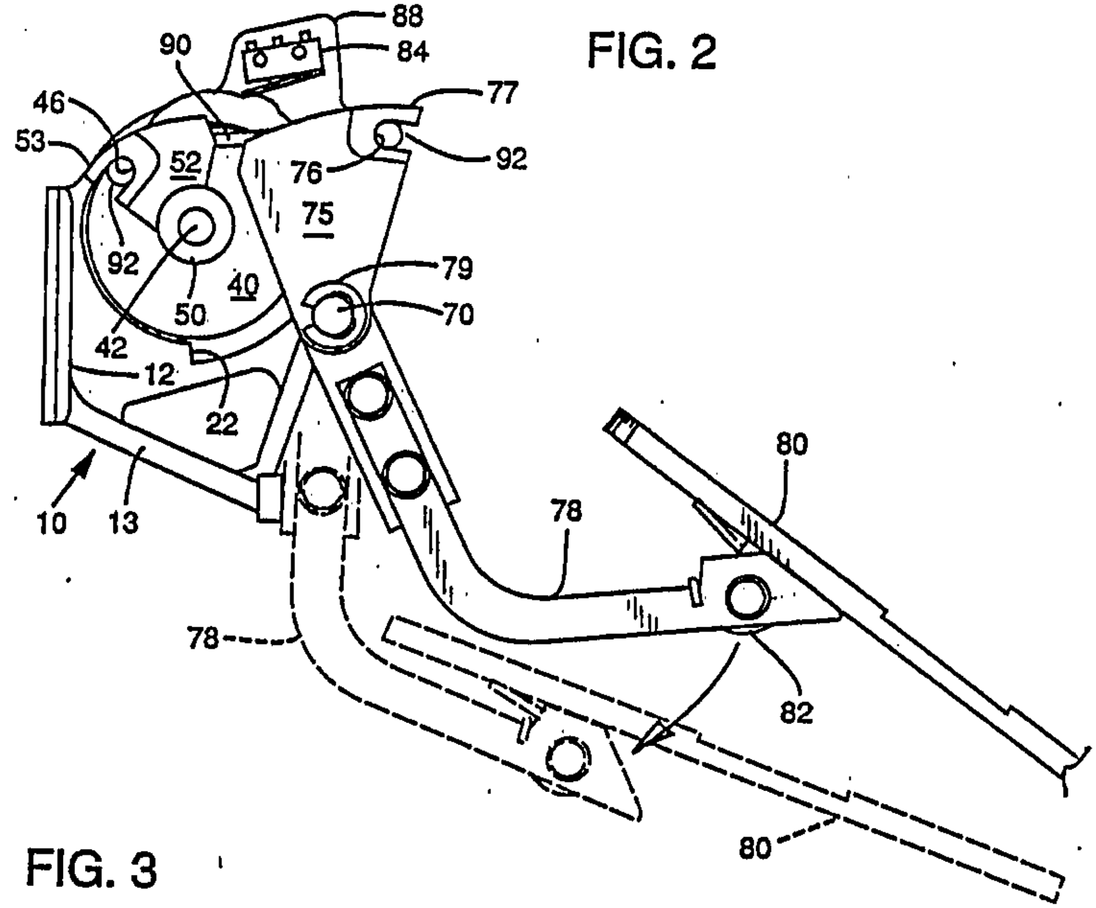

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FIG. 3

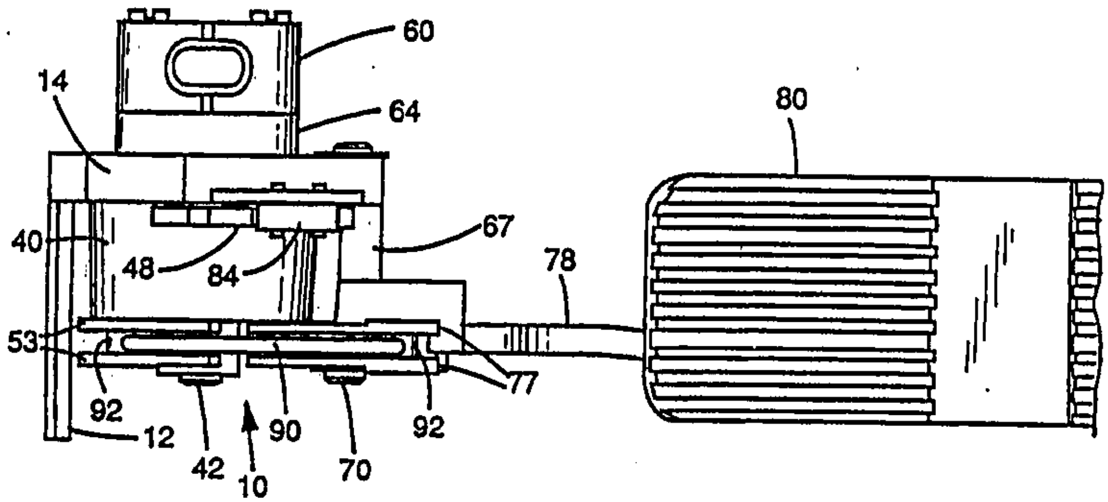

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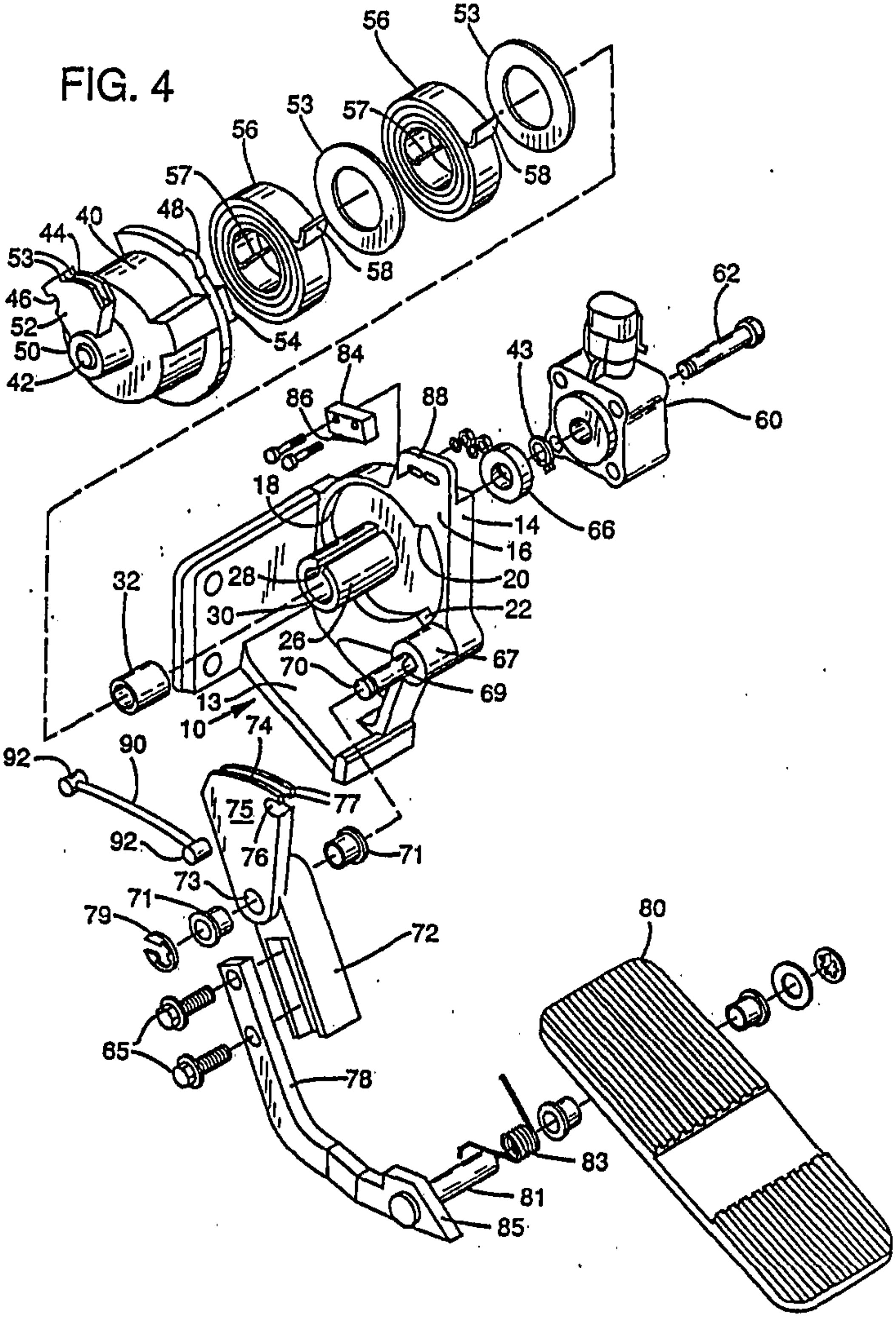
FIG. 4



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FOOT PEDAL ARRANGEMENT FOR ELECTRONIC THROTTLE CONTROL OF TRUCK ENGINES

FIELD OF THE INVENTION

The present invention relates to a foot pedal used for electronic throttle control in diesel engine powered trucks, and in particular it relates to a foot pedal that is mounted on the front wall of the truck cab in a manner that permits conventional foot pedal control.

BACKGROUND OF THE INVENTION

Controlling the rate of fuel dispensed to the cylinders, commonly referred to as throttle control, in diesel engines is accomplished by adjusting the output of the fuel pump. Throttle controls have evolved from a mechanical linkage directly connecting a foot pedal to the fuel pump, to an electronic linkage between the foot pedal and a computer, the computer then controlling the fuel pump.

Prior to the electronic inter-connection, a foot pedal was mechanically linked to the fuel pump and actuation of the foot pedal altered the output of fuel pumped by the fuel pump. The foot pedal was held in the home or idle position by a spring arrangement and the operator would merely depress the pedal to increase the fuel output of the pump thereby controlling the RPM and/or power output of the engine. The linkage of the pedal to the pump was proportional, the more the pedal was depressed, the more fuel was delivered to the cylinders. Fuel dispensing was then based purely on the demand of the operator.

The current trend in diesel engines is electronic control of the fuel pump output. The fuel pump is computer controlled and reacts to an input signal from the foot pedal. In the electronic or computer controlled system, the operator still utilizes a foot pedal. Instead of being mechanically linked to the pump, the pedal depression is monitored by a computer. The monitoring function is achieved through the use of a potentiometer. The potentiometer is rotated with depression of the pedal and provides an input signal to the computer.

The computer controls the fuel pump output based on input data from the potentiometer but it also factors in other data such as temperature, humidity, engine load, etc. to provide increased efficiency, economy of operation, and to reduce undesirable emissions to the atmosphere.

Initially the potentiometer was located in the engine compartment near the fuel pump. This was an undesirable arrangement due to the complex mechanical linkage required to connect the foot pedal to the potentiometer. The operating environment was also a problem in that it exposed the potentiometer to heat, oil and dirt that many believed caused premature failure of the potentiometer. The potentiometer was then incorporated in a foot pedal assembly structure that included a means for providing rotative motion of the potentiometer in reaction to depression of the pedal. This pedal assembly was floor mounted, and limited the design configuration and placement. Making adaptions to differing potentiometers that required a different degree of rotation created a major design change. At times, the modified design configuration required that operator convenience be compromised.

SUMMARY

The present invention, as in the prior art electronic throttle controls, utilizes a rotary potentiometer to monitor the foot pedal depression for the computer. However, the unique arrangement of the components and the method of providing rotary motion to the potentiometer allows a suspended pedal arrangement that provides operator convenience not previously available.

In the preferred embodiment of the invention, a specially configured support structure is mounted to the front wall of the truck cab. The front wall is here intended to mean the vertical or near vertical wall that is forward of the truck driver's feet and thus in front of the foot pedals (brake and accelerator pedals) that are manipulated by the driver. The invention is directed to the accelerator foot pedal and hereafter the term "foot pedal" will be used to refer to the accelerator foot pedal.

The support structure provides a pivot for the foot pedal (referred to as a suspended foot pedal as differentiated from a floor mounted foot pedal) and a pivotal mounting for a spring loaded spool that is connected to the potentiometer. An extended segment of the foot pedal acts as a lever and is connected through a cable to the spool. The manner of connection of the cable to the spool and foot pedal establishes a relative movement between the spool and foot pedal whereby the typical range of foot pedal movement translates into the required rotative movement of the spool and thus the potentiometer. The foot pedal, spool, potentiometer and their various components are sometimes collectively referred to as a "foot pedal arrangement".

The support structure includes a stop to limit the foot pedal movement and a safety or idle validation switch that is engaged by the spool to confirm idle mode, i.e. with the foot pedal in the fully retracted (non-depressed) state. The invention will be more fully understood with reference to the following detailed description and drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a foot pedal arrangement in accordance with the present invention;

FIG. 2 is a side view of the foot pedal arrangement of FIG. 1;

FIG. 3 is a top view of the foot pedal arrangement of FIGS. 1 and 2; and

FIG. 4 is a perspective exploded view illustrating the various components of the foot pedal arrangement of FIGS. 1, 2 and 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, the foot pedal arrangement 10 has a mounting base 12 configured to be rigidly attached to the front wall 11 in a cab of a diesel engine powered truck. Affixed to the base 12 is a plate-like support structure 14. The support structure 14 extends outwardly from the base 12 and has a formed recess 18 in side 16 (see FIG. 4). The formed recess 18 has radial limit stops 20 and 22. Extending outwardly out of the recess 18 and beyond the side 16 is a cylindrical hub 26, having a longitudinal groove 28 in its periphery. On the side opposite side 16 (see FIG. 3) is a pad 64 integral with structure 14, that is positioned in alignment with the hub 26. The hub 26, structure 14 and pad 64 have a common through bore 30. The outward end

of hub 26 is counter-bored to accept bearing 32 (see FIG. 4) and the pad 64 is counter-bored to accept bearing 66. These features of support structure 14 provide the support and inter-connection for the spool and potentiometer to be later described.

A stud portion 67 extends from side 16 spaced outwardly from recess 18. A second bore 69 into the stud portion 67 of structure 14 is parallel to the bore 30. A pivot shaft 70 is supported in bore 69. Extending upwardly along side 16, above the recess 18, is a flange 88 that is slotted for adjustably mounting a micro-switch 84. Projected from the lower edge of base 12 is a brace portion 13 that also functions as a stop to limit pivoting of the foot pedal. The above describes the support structure. The foot pedal, spool and potentiometer supported on the support structure will now be described.

A spool 40, generally in the shape of an open ended cylinder and having a center cavity, is provided with a shaft 42 that has one end rigidly attached to a hub 50 at the closed end of the spool. The shaft 42 extends through and beyond the cavity of the spool 40. Projecting radially outward from the hub 50 and adjacent the closed end of spool 40 is a configured segment 52, and on the periphery of segment 52 is a carrier 44. The carrier 44 of segment 52 is a formed groove having parallel sides with the bottom surface of the groove curved, the curvature being an arc concentric (coaxial) to the shaft 42. The ends 53 of the parallel sides have notches 46.

A shaped cam 48 on the periphery of the spool 40 is formed near the open end of spool 40. A lobe 54 projects outwardly from the cylindrical surface of the spool 40. As illustrated, the lobe 54 extends the length of the spool 40. The lobe 54 has a slot that is open to the cavity of the spool and is arranged to receive the external flanges 58 of a pair of torque springs 56. Spacer washers 53 separate the springs from each other and from the inner face of the recess 18.

The foot pedal includes a pivot arm 72 having a bore 73. Projecting radially from the bore 73 is a configured segment 75, and on the periphery of segment 75 is a carrier 74. The carrier 74, like carrier 44, is a formed groove having parallel sides, with the bottom of the groove curved, the curvature being an arc concentric (coaxial) to the bore 73. The ends 77 of the parallel sides have notches 76.

Extended from pivot arm 72 (attached by screws 65) opposite to the extension of segment 75 from bore 73, is a pedal arm 78. A foot pedal 80 is attached to arm 78 by a pin 81 projected through the arm 78 and receiving lugs 82 on the bottom of pedal 80 (see FIG. 2). A spring 83 urges the pedal 80 against an angled landing 85 on arm 78.

A flexible link, in the form of a cable 90, has dowels 92 affixed transversely at each of its ends. The dowels 92 engage the notches 46, 76 of the carriers 44 and 74 with the cable fitting in the grooves of the carriers thereby providing a linkage between the spool 40 and the foot pedal components (72, 78, 80).

As previously explained, the spool 40 has spirally wound tension springs 56 and washers 53 inserted within the cavity of the spool, with the outer flanges 58 of the springs engaging the slot of the lobe 54. The inner flanges of the springs 56 fit in the groove 28 of the hub 26. The spool shaft 42 is rotatably mounted in bearings 32 and 66 and is axially retained by a retainer 43. The shaft 42 extends into and couples with the input shaft of

the potentiometer 60 that is attached to pad 64 by fasteners 62.

The springs 56 apply a yieldable rotative force to the spool 40, with the rotation of spool 40 limited by the engagement of the lobe 54 against the limit stop 20. This rotative position of the spool and, therefore, the rotative position of the potentiometer (since they are coupled), is referred to as the home position or the idle mode.

Adjustably mounted to the flange 88 by threaded fasteners is a micro-switch 84. The micro-switch operating lever 86 is aligned and engages the cam 48 of spool 40. When the spool 40 and potentiometer 60 are in the home or idle mode, the operating lever 86 will have actuated the micro-switch thereby providing an idle mode confirmation signal to the computer by connecting line 94.

The pivot arm 72 is rotatably bearing mounted on the pivot shaft 70 projected into bore 69 of structure 14, by bearings 71. The pivot shaft 70 has a retainer 79 to secure the pivot arm 72 on the shaft 70.

The carriers 44 and 74 are in alignment one with the other and the cable 90 is aligned in the grooves of the carriers with the dowels 92 slidably engaging the notches 46 and 76 of the carriers.

In operation, the foot pedal 80 is depressed, pivoting the pivot arm 72 about the pivot shaft 70. This pivoting action provides motion to the carrier 74 which is transmitted to the carrier 44 through the cable 90, causing a rotative motion of the spool 40 which in turn rotates the potentiometer 60. Note that a limit stop 22 in the recess 18 limits the rotation of the spool 40. The degree of rotation between limit stops 20 and 22 is dictated by the rotational requirement needed by the potentiometer to have a minimum to maximum output value.

Depressing the pedal fully rotates the spool and the potentiometer the maximum degrees allowed, the rotation being limited by the limit stop 22. This maximum rotation provides a signal to computer 93 through a connecting line 95 for maximum engine RPM. The pedal depression is infinitely adjustable from idle to maximum RPM. The rate of the RPM of the engine is proportioned to the pedal displacement, i.e. due to computer response to the monitoring of the spool rotation.

The pivot arm in the preferred embodiment illustrated has an ideal angular motion of 27 degrees. This is considered to be the best arrangement for operator utilization, safety and comfort.

The rotational requirement of the potentiometer 60 determines the amount of angular rotation of the spool 40. In the preferred embodiment, the potentiometer requires a rotation of 53 degrees. Therefore, the limit stops 20 and 22 are spaced angularly at fifty-three degrees plus a compensation in consideration of the width of the lobe 54. The ratio of the radial distance of the curved surface of carrier 74 engaged by the cable 90 to the radial distance of the corresponding curved surface of carrier 44 is therefore two-to-one, respectively. The additional degree of rotation that would be imparted to the spool is attributed to the "lost motion" of the connecting members of the flexible link and the carriers due to the allowable tolerance of fit.

The capability of adjusting the aforementioned ratio of the radii and the angular displacement of the limit stops provides an electronic throttle control that is easily adapted to differing potentiometers.

The configuration of the support structure provides a suspended type pedal design, unlimited in its configuration.

The micro-switch 84 provides an idle mode confirmation signal that is a safety feature in the event of potentiometer failure. Regardless of the signal generated by the potentiometer, with the foot pedal in the home position, the switch 84 signals the computer 93 through the connecting line cable 94 of the desired idle mode, thereby overriding the potentiometer.

Dual springs 56 are provided for safety in the event one of the springs breaks. The torque applied by one spring is adequate to return the spool to the home or idle position.

Other arrangements will be apparent from the above disclosure. Accordingly, the scope of the invention is not limited to the drawings and descriptions but is determined by the appended claims.

What is claimed is:

1. a foot pedal arrangement for controlling the throttle of an internal combustion engine in a vehicle comprising; a configured integral support structure having a base adapted for mounting onto the upright wall of a vehicle cab, a foot pedal pivotally mounted on the support structure, a throttle controlling computer, and monitoring means connected to the computer, said monitoring means mounted to the support structure, linear coupling means coupling the monitoring means and foot pedal whereby pivotal movement of the foot pedal is linearly monitored by the monitoring means for proportioriate input to the computer for controlling engine throttle, said foot pedal, monitoring means and coupling means being mounted on the support structure for unitized mounting thereof onto the upright wall of a vehicle cab.

2. A foot pedal arrangement for controlling a throttle of an internal combustion engine in a vehicle, comprising;

- a support structure adapted for mounting onto the upright wall of a vehicle cab;
- a foot pedal pivotally mounted on the support structure;
- a throttle controlling computer;
- monitoring means for monitoring pivotal movement of the foot pedal connected to the computer, said monitoring means mounted to the support structure; and
- coupling means for coupling the monitoring means and foot pedal;
- said monitoring means comprising a potentiometer and a rotatable spring biased spool;
- said spool connected to the potentiometer whereby rotation of the spool is monitored by the potentiometer, said spool having minimum and maximum rotative limits and said foot pedal having minimum and maximum pivotal positions, said foot pedal pivotal movement between minimum and maximum positions being pivoted through a determined angle that is less than the rotative movement between minimum and maximum limits of the spool, and said coupling means including translation means to proportionately translate the minium to maxium movement of the foot pedal to corresponding minimum to maxium movement of the spool.

3. A foot pedal arrangement as defined in claim 2 wherein the translation means comprises; a flexible link between the spool and foot pedal, the effective connection of the flexible link to the spool being at a first determined distance from the axis of rotation of the spool, and the effective connection of the flexible link to the foot pedal being at a second determined distance from the axis of pivoting of the foot pedal, said first determined distance and second determined distance having a ratio corresponding to the ratio of the angle of movement from minimum to maximum for the foot pedal and the spool, respectively.

4. A foot pedal arrangement as defined in claim 3 wherein the effective connections of the flexible link are at a curved carrier surface provided on each of the spool and foot pedal, the curved surfaces formed as the radial distances corresponding to the first determined distance and second determined distance for the spool and foot pedal respectively, said flexible link riding over the carrier surfaces whereby the flexible link engages a point of tangency on each of the curved carrier surfaces throughout the minimum to maximum movement of the spool and foot pedal.

5. A foot pedal arrangement as defined in claim 4 wherein the spool is rotatably mounted on the support structure forward of the pivotal movement of the foot pedal, said foot pedal including a pedal portion and an arm portion, the pivotal connection being to the arm portion and an arm extension projected beyond the pivotal connection and the carrier surface of the foot pedal provided at the arm extension whereby pivoting of the pedal portion forward forces pivoting of the arm extension rearward to draw the flexible link and force rotation of the spool.

6. A foot pedal arrangement as defined in claim 2 wherein said minimum position of the pedal and accordingly said minimum limit of the spool defines a desired idle mode of the engine, a detecting means mounted to the support structure detects the minimum rotative position of the spool, said detecting means directly connected to the computer to indicate the desired idle mode regardless of the input from the potentiometer.

7. A foot pedal arrangement indirectly controlling the throttle of an internal combustion engine that is directly controlled by a computer comprising;

- a configured support structure including a base attached to an upright wall of an internal combustion engine powered truck, a plate-like support projected from the base,
- a spool rotatably mounted to one side of the plate-like support and defining an axis of rotation, a shaft fixed to the spool and projected through a bore in the plate-like support, a potentiometer connected to the spool shaft on the opposite side of the plate-like support, stop limits on the support structure defining minimum and maximum rotative positions of the spool, and spring biasing means for biasing the spool toward the minimum position,
- a foot pedal arm pivotally attached to the plate-like support and defining a pivotal axis parallel to and spaced from the axis of rotation of the spool, said arm having a lower portion extended below the pivot and an upper portion extended above the pivot, a foot pedal mounted to the lower portion,
- a first curved carrier portion on the spool defined by a radius projected from the axis of rotation of the spool, a second curved carrier portion on the upper portion of the foot pedal arm defined by a radius projected from the pivotal axis of the arm, a flexible link attached to the spool and upper portion of the arm, said flexible link extended over the first and second curved carrier portions, said first and second curved carrier portions relatively arranged whereby the flexible link is projected as a tangent to both curved portions throughout rotation of the

spool between minimum and maximum positions, and

a computer, said potentiometer connected to the computer, said potentiometer monitoring the rotative positions of the spool shaft generated by rota-

tion of the spool between minimum and maximum positions.

8. A foot pedal arrangement as defined in claim 7 wherein a detector on the plate-like support detects the minimum position of the spool, said detector connected to the computer to input the minimum position of the spool independent of the potentiometer.

* * * * *

08/10/93 XR 5,233,882

US005233882A

United States Patent [19]

Byram et al.

[11] Patent Number: 5,233,882

[45] Date of Patent: Aug. 10, 1993

[54] REMOTE CONTROL LEVER MODULE

[75] Inventors: Robert J. Byram, Grand Blanc; Bryan S. Kikta, Davison, both of Mich.; Kevin R. Keegan, Hilton, N.Y.; Daniel F. Smith, Conesus, N.Y.; Donald G. Witzel, Fairport, N.Y.; Daniel A. Crawford, Flint, Mich.; Steven A. Kornburger, Davisburg, Mich.; Lisa M. Unuvar, Flint, Mich.

[73] Assignee: General Motors Corporation, Detroit, Mich.

[21] Appl. No.: 692,375

[22] Filed: Apr. 26, 1991

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 552,173, Jul. 12, 1990, abandoned.

[51] Int. Cl.[5] G05G 1/14

[52] U.S. Cl. 74/514; 74/512; 74/560; 123/399; 192/1.56; 307/10.1

[58] Field of Search .... 307/10.1; 74/512-514, 74/560; 123/399, 361; 340/453; 192/1.56, 1.43, 8 C; 180/335; 73/118.1, 116; 338/32 R

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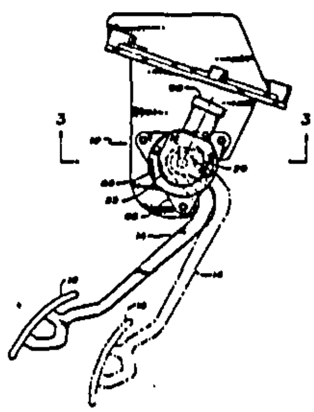
Primary Examiner—Vinh T. Luong
Attorney, Agent, or Firm—Gordon F. Belcher; C. K. Veenstra

[57] **ABSTRACT**

A remote control lever module comprises an inner shaft coaxially located inside an outer shaft. The inner and outer shafts are rotatably mounted on a support and can rotate with respect to one another. A return mechanism is engageable with the inner and outer shafts enabling forward rotation of the inner shaft to cause forward rotation of the outer shaft. The return mechanism further enables extended forward rotation of the inner shaft with respect to the outer shaft, and urges backward rotation of the inner shaft to a rearmost position. The return mechanism limits backward rotation of the inner and outer shafts beyond a nonactuating position. A force spring urges the outer shaft to the nonactuating position. Sensors produce electrical signals proportional to the angular position of the inner and outer shafts. A friction pad can be disposed between the inner shaft and support to frictionally resist rotation of the inner shaft with respect to the support.

22 Claims, 8 Drawing Sheets



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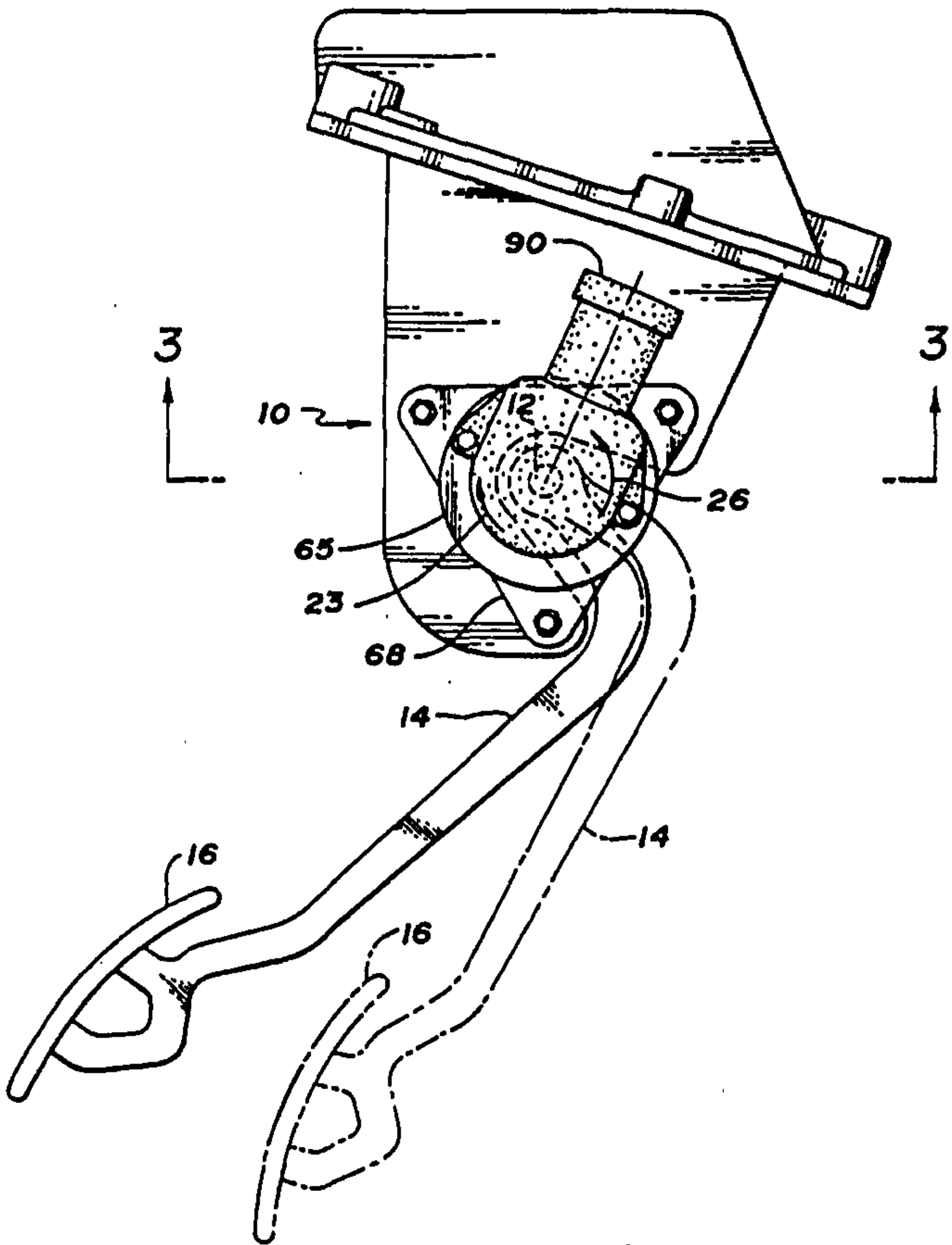
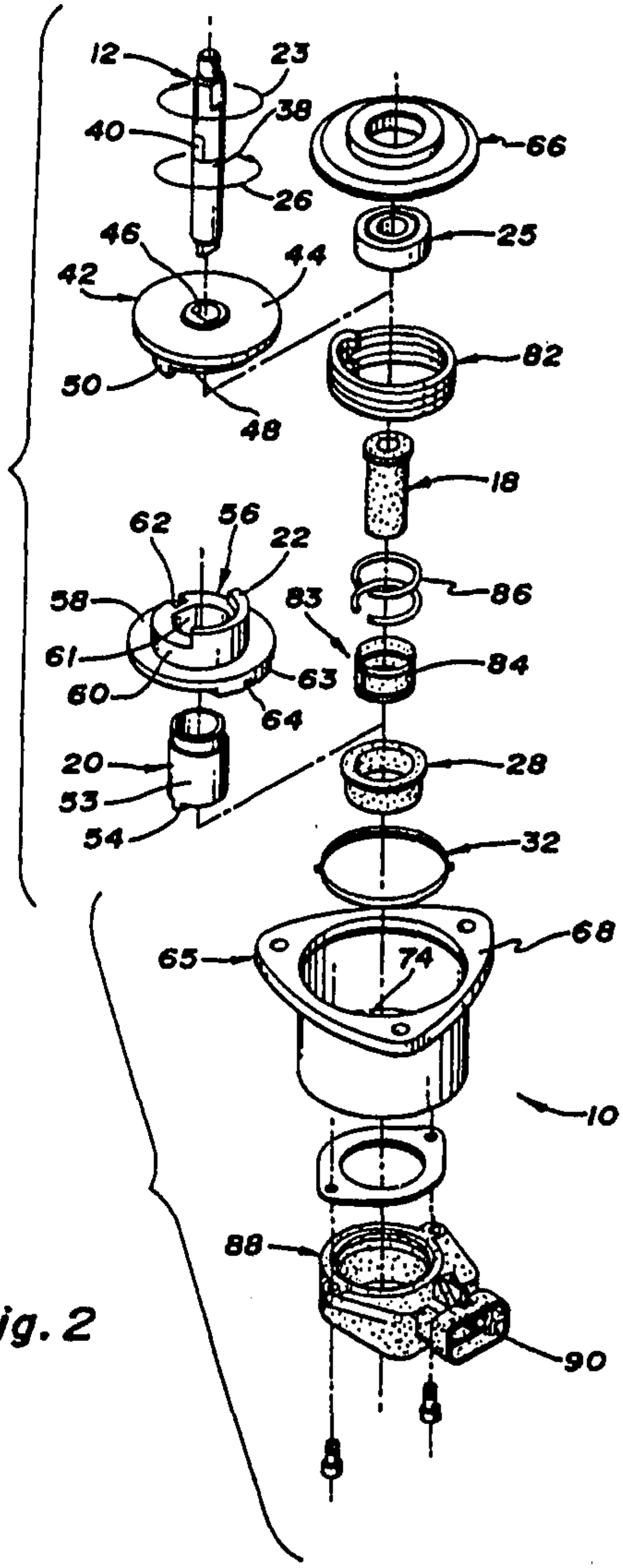


Fig. 1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46
44
42
82
50
48
18
62
56
22
58
86
83
61
84
63
60
64
20
28
53
54
32
65
68
74
10
88
90

Fig. 2

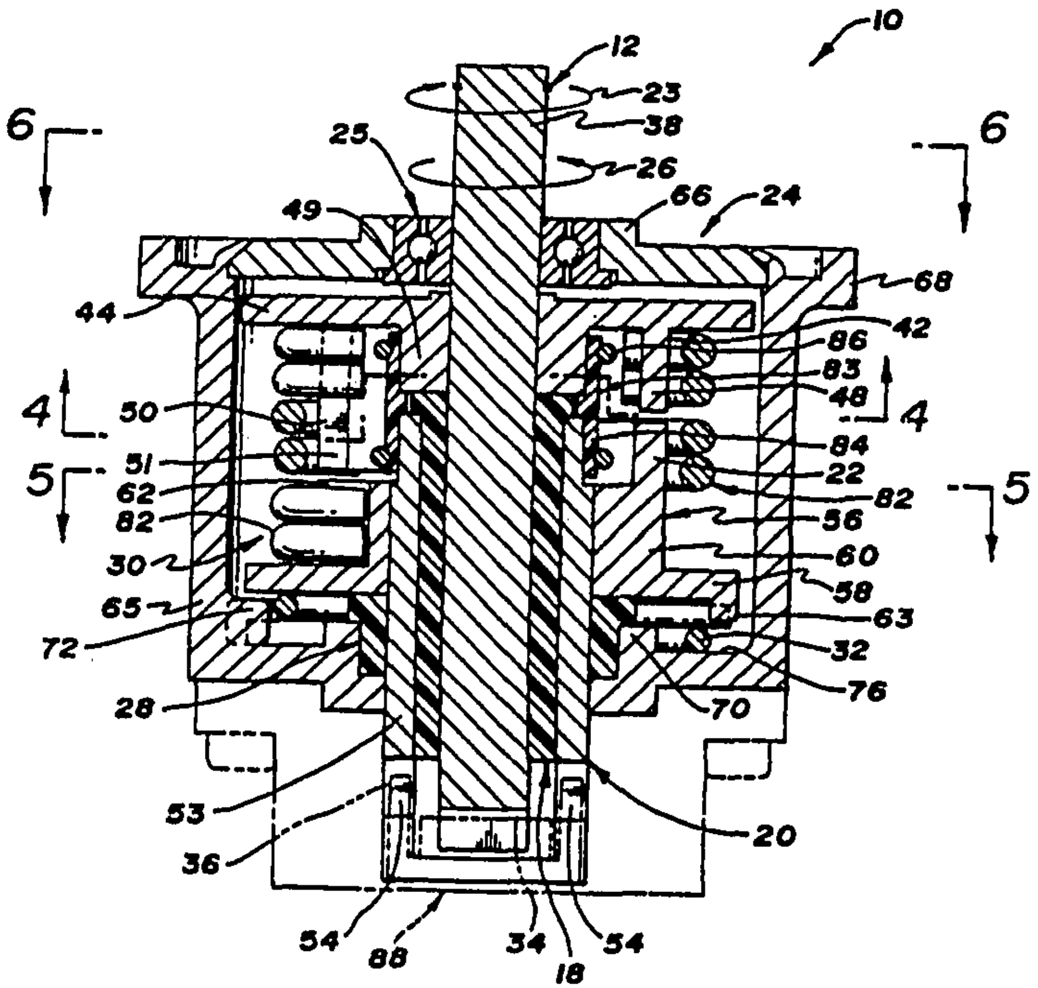
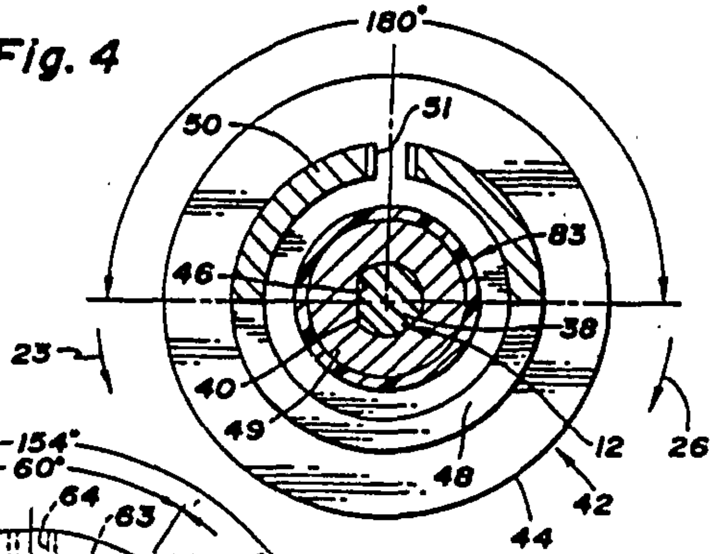

10
12
23
38
26
25
6
6
49
66
24
68
44
42
86
83
48
4
4
50
51
84
22
5
5
62
82
82
56
30
60
58
65
63
72
32
76
28
70
53
20
36
54
88
34
54
18

Fig. 3

Fig. 4



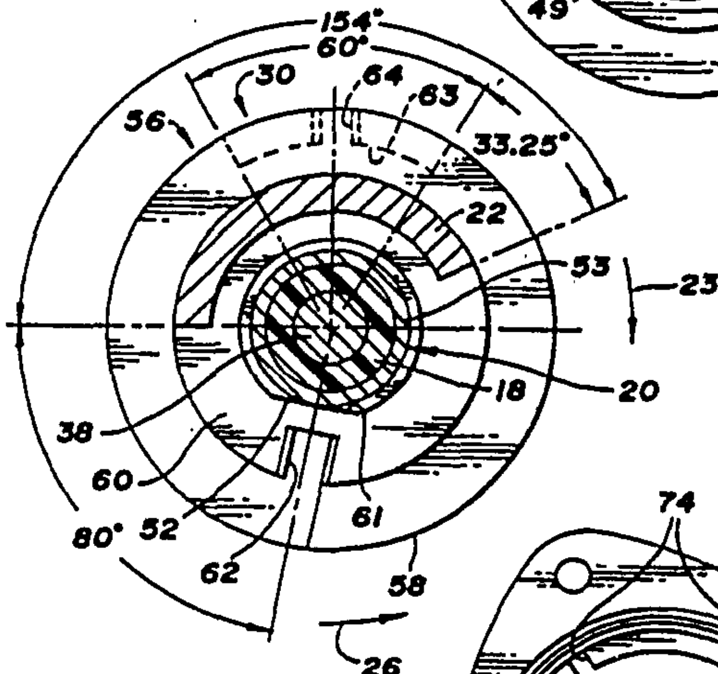


Fig. 5

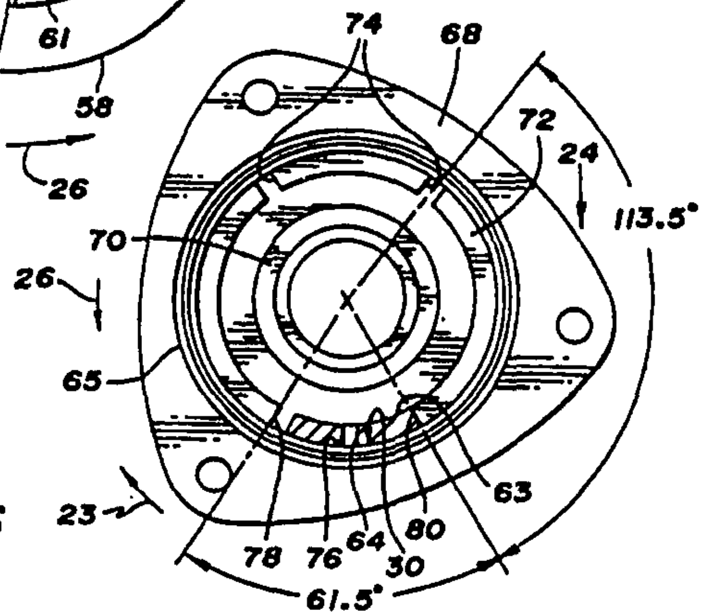


Fig. 6

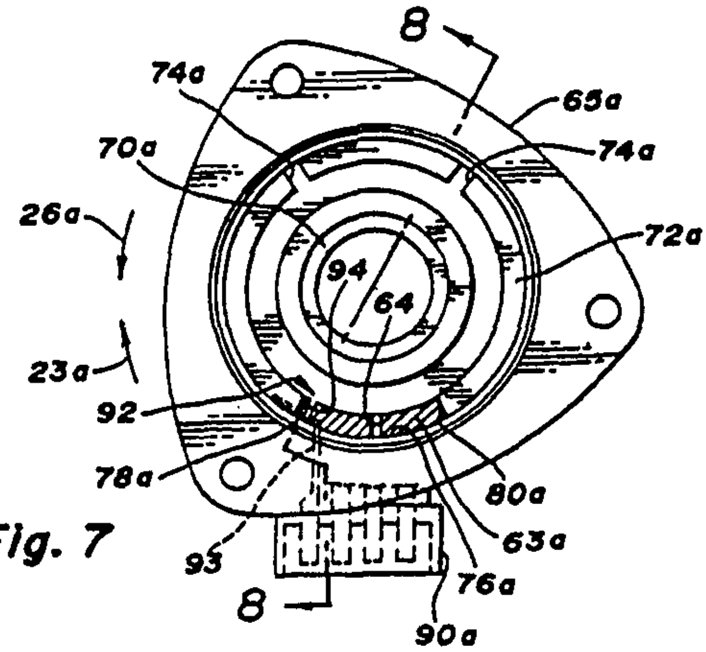
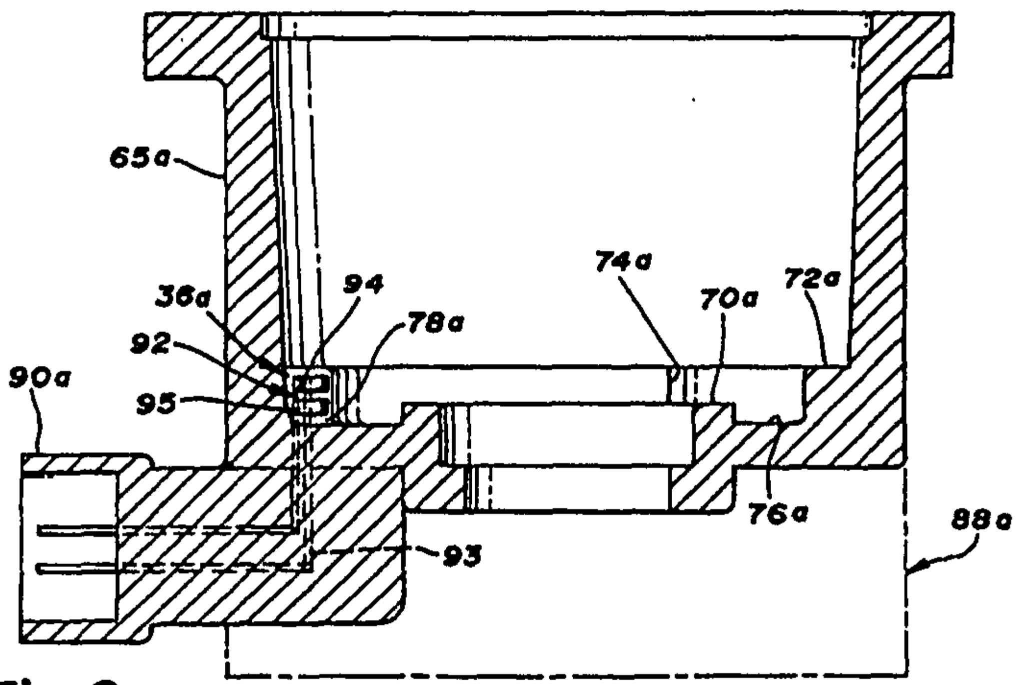

8
74a
65a
70a
74a
26a
72a
94
64
23a
92
78a
80a
63a
93
76a
8
90a

Fig. 7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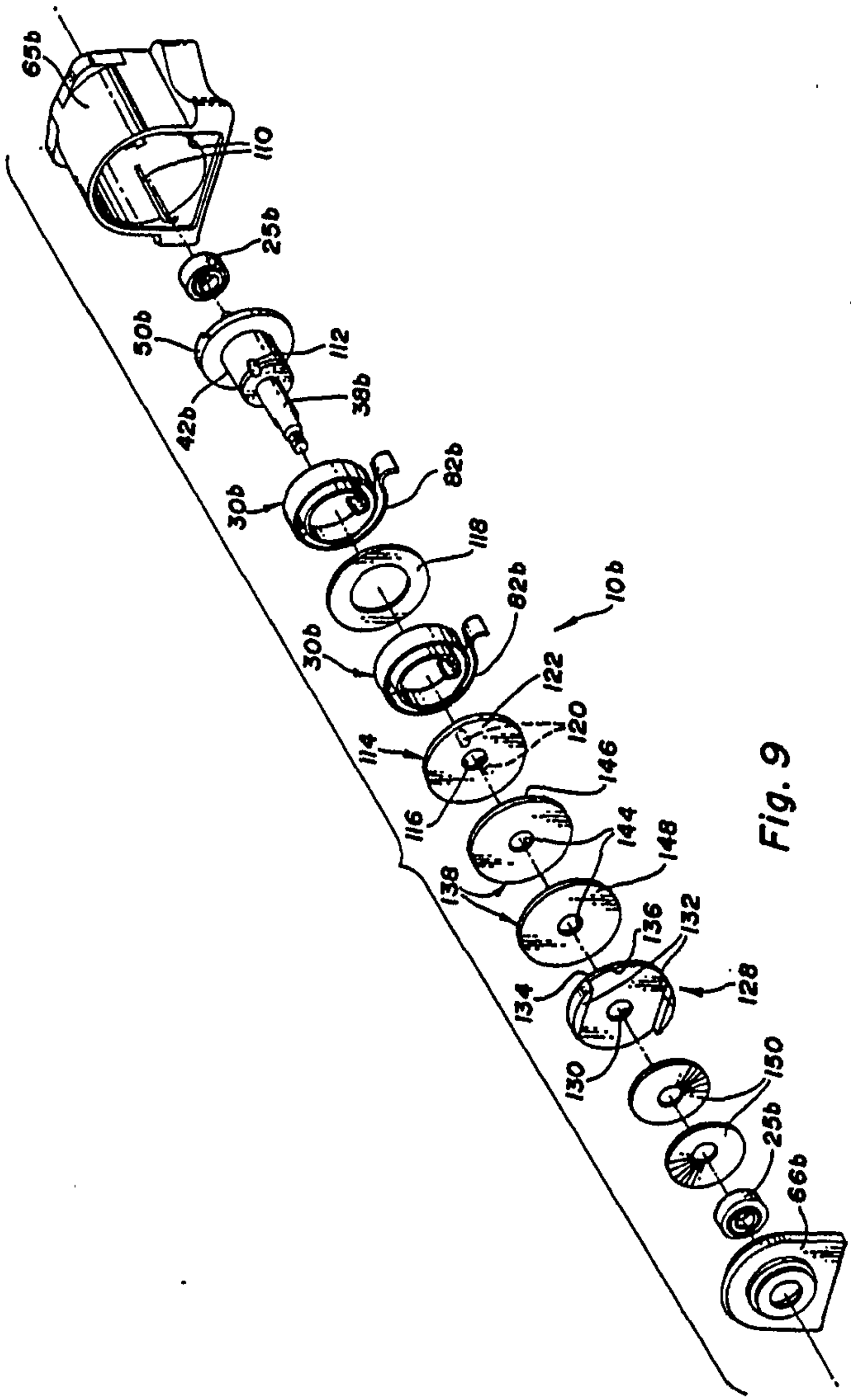
74a
36a
94
72a
70a
78a
92
90a
95
76a
88a
93

Fig. 8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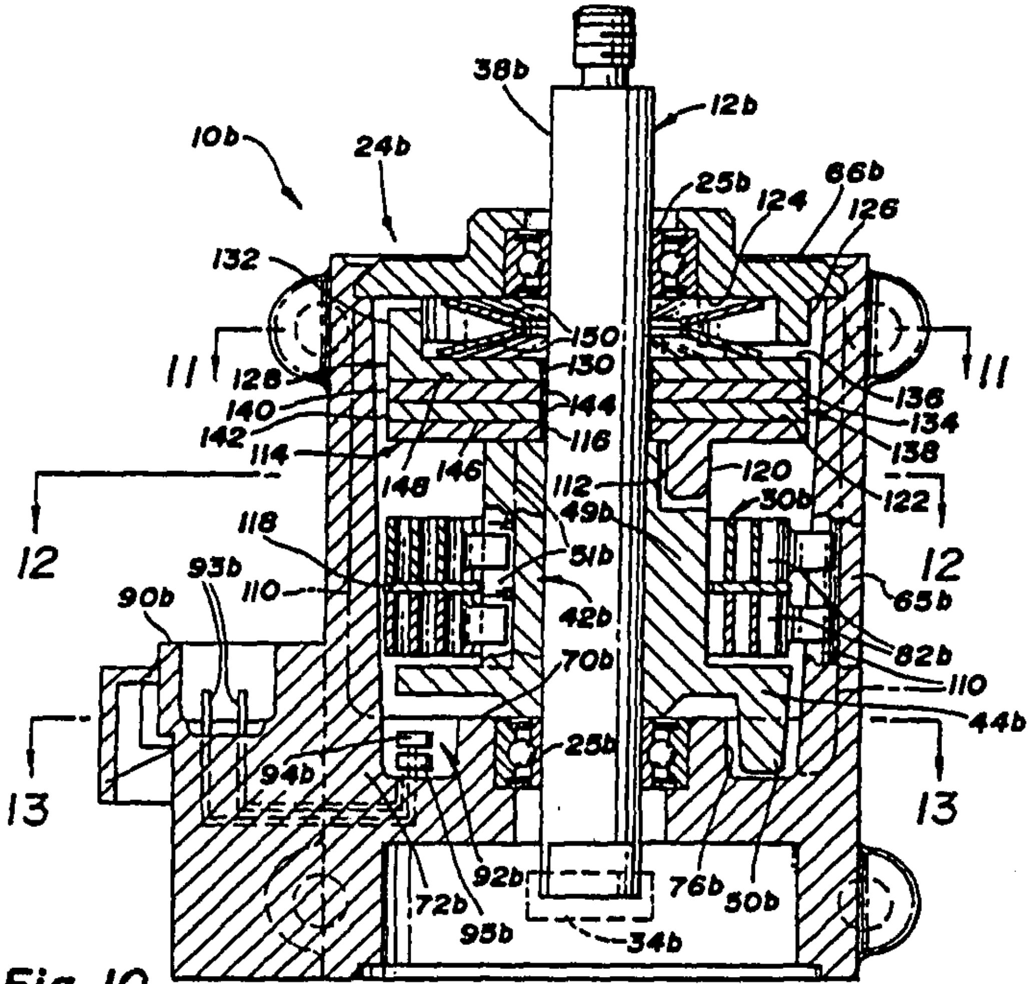
25b
50b
112
42b
38b
30b
82b
118
82b
10b
30b
122
120
114
146
116
144
148
138
136
132
134
128
130
150
25b
66b

Fig. 9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10b
24b
25b
124
66b
126
132
150
130
11
11
128
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142
116
138
114
146
148
112
120
122
30b
118
49b
12
12
93b
51b
65b
110
90b
42b
82b
70b
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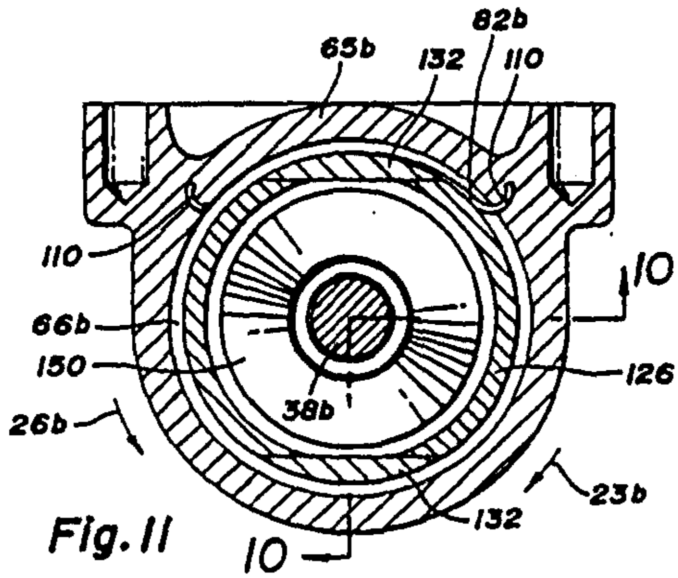
44b
25b
94b
13
13
92b
76b
50b
72b
95b
34b

Fig. 10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132
110
110
10
66b
150
126
38b
26b
23b
132
10

Fig. 11

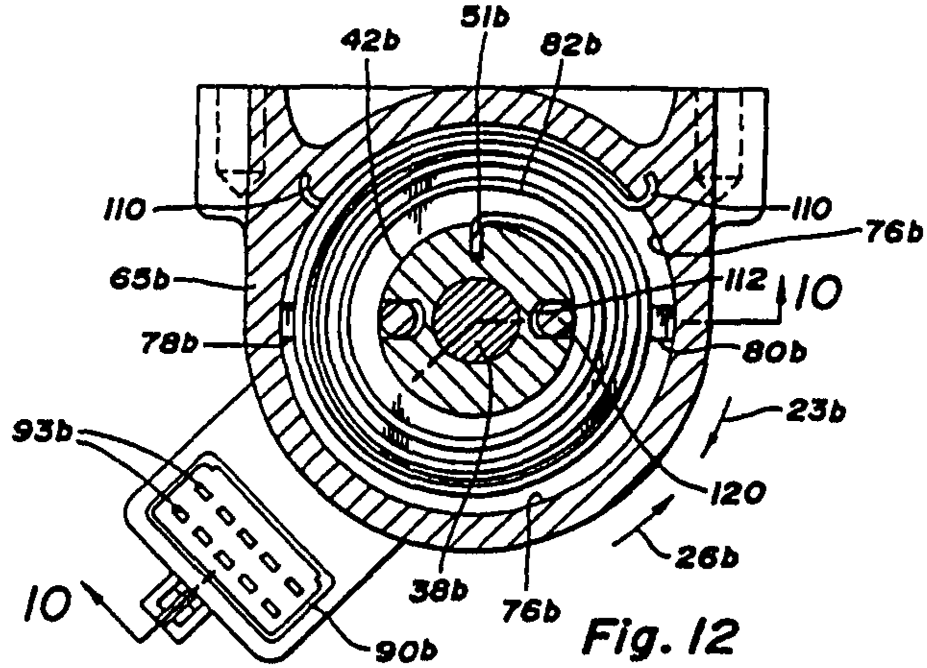
51b
42b
82b
110
110
76b
65b
112
10
78b
80b
93b
23b
120
26b
10
38b
76b
90b

Fig. 12

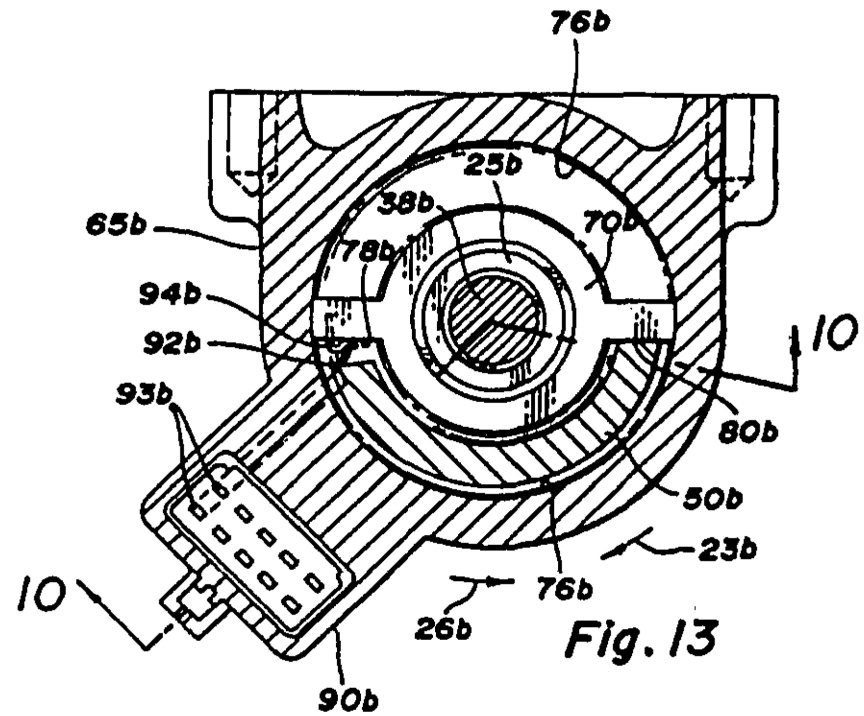
76b
25b
38b
65b
70b
78b
94b
92b
10
93b
80b
50b
23b
10
76b
26b
90b

Fig. 13

REMOTE CONTROL LEVER MODULE

This application is a continuation-in-part of application Ser. No. 552173, filed, Jul. 12, 1990 entitled "REMOTE CONTROL LEVER MODULE", now abandoned.

BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates to a remote control lever module for sensing movement of a lever. More particularly, the invention relates to a remote control lever module for sensing the angular position of a pedal lever for an electronic vehicle control system. The lever module may be further adapted to include hysteresis to simulate the feel of a purely mechanical linkage (i.e., a pedal lever connected to a throttle valve via a cable), and to sense engagement of the pedal lever by the operator.

2. Background Art

Vehicle engine control systems are known having a sensor, such as a potentiometer, connected to an accelerator pedal for measuring the displacement of the accelerator pedal. A force sensor, such as a resistive strain gauge, is connected to the accelerator pedal which is able to sense whether a force is being applied to the pedal, such as by the operator stepping thereon. The electronic control module (ECM) is programmed to sense the signal produced by the force sensor and cause the engine to idle if there is no force sensed, even if the potentiometer indicates displacement of the pedal. This reduces the possibility of unintended movement of the vehicle by a reason other than the operator stepping on the accelerator pedal.

Such vehicle engine control systems can require considerable effort to package and install in a vehicle since they require multiple connections to the pedal and a portion of the vehicle which is stationary with respect to the vehicle, such as the bulkhead. Also, the potentiometer can vary in size as the pedal is displaced, and can be located apart from the force sensor further complicating packaging of the system.

An accelerator control apparatus is also known including a single shaft which rotates in proportion to the displacement of an accelerator pedal. The shaft is coupled to a position sensor which measures the rotation of the shaft. The shaft is also linked to a pedal sensor switch which is opened and closed by movement of the shaft corresponding to initial displacement of the undepressed pedal and return of the displaced pedal to the undisplaced position. A comparison of the signals from the position sensor and pedal sensor can indicate the integrity of the apparatus. The apparatus can also include a dual coiled return spring having coils of approximately the same size. The single shaft and limited number of return spring coils can limit the sensitivity of the apparatus to external forces applied to the pedal.

An accelerating pedal is also known including a single shaft which rotates in proportion to the displacement of the pedal. The shaft can be coupled to a position sensor which measures the rotation of the shaft. The shaft includes a disk which rotates therewith. The disk fits between pads which are fixed to a housing within which the shaft rotates When the shaft rotates, the pads exert a frictional force on the disk to create a desired hysteresis effect. The surface of the pads which engage the disk, as well as the surfaces of the disk which engage the pad, must be finished to produce the desired hysteresis effect yet enable the return spring to backwardly rotate the shaft when the operator ceases to depress the pedal. This can limit the permissible variations in surface finishes of the disk and pads.

SUMMARY OF THE INVENTION

The present invention provides a remote control lever module for sensing the angular position of a lever. Such control lever modules are particularly suited for use in electronic vehicle control systems for sensing the angular position and actuation of a pedal lever.

The remote control lever module comprises an inner shaft coaxially located inside an outer shaft enabling relative rotation between the shafts. The outer shaft has an outer shaft stop engageable with the inner shaft to limit backward rotation of the inner shaft with respect to the outer shaft. A return means is engageable with the inner and outer shafts enabling forward rotation of the inner shaft to cause forward rotation of the outer shaft. The return means further enables forward rotation of the inner shaft away from a rearmost position, and urges the inner shaft to the rearmost position when the inner shaft has forwardly rotated away from the rearmost position. The return means limits backward rotation of the inner and outer shafts beyond a nonactuating position A force spring urges the outer shaft to the nonactuating position when the outer shaft is forwardly rotated away from the nonactuating position. Sensors produce electrical signals proportional to the angular position of the inner and outer shafts with respect to the support means.

The transmission of rotation from the inner shaft to the outer shaft, and the capability to sense the rotation of the inner and outer shaft means, via the inner and outer shaft sensors, enables sensing of the condition of the return spring, force spring, outer shaft bearing and intermediate bearing. This is due to the initial rotation of the inner shaft ordinarily producing rotation of the outer shaft. Also, when the outer shaft is at the nonactuated position, the inner shaft should be at the same position. Any deviations from these conditions can indicate that an examination of the lever module is warranted.

The lever module may also include a friction pad disposed between the inner shaft and a support member which is fixed to the support means during at least a portion of the rotation of the inner shaft. The friction pad has a first friction surface in engagement with the inner shaft to frictionally resist relative displacement between the friction pad and inner shaft. The friction pad has a second friction surface in engagement with the support member to frictionally resist relative displacement between the friction pad and support member The frictional resistance provided by the first and second friction surfaces provides a desired hysteresis effect. Also, the first and second friction surfaces can each separately permit relative rotation between the inner shaft and support means, independently of the other friction surface.

These and other features and advantages of the invention will be more fully understood from the following description of certain specific embodiments of the invention taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a side elevational view of the remote control lever module connected to a pedal and vehicle;

FIG. 2 is an exploded view of the remote control lever module of the present invention; and

FIG. 3 is an enlarged cross sectional view of the lever module generally in the plane indicated by line 3—3 of FIG 1;

FIG. 4 is a cross sectional view of the lever module generally in the plane indicated by the line 4—4 of FIG. 3 showing the inner shaft collar;

FIG. 5 is a cross sectional view of the lever module generally in the plane indicated by the line 5—5 of FIG. 3 showing the outer shaft collar;

FIG. 6 is a view of the lever module generally in the plane indicated by the line 6—6 of FIG. 3 showing the support housing with the parts, other than the return stop, being removed from it;

FIG. 7 is a view corresponding to FIG. 6 showing a second of the switch;

FIG. 8 is a sectional view of FIG. 7 in a plane corresponding to the plane indicated by the line 8—8 of FIG. 6 showing the second embodiment of the switch;

FIG. 9 is an exploded view of a second embodiment of the lever module;

FIG. 10 is a view corresponding to FIG. 3 showing the second embodiment of the lever module, with parts being broken away to show the inner and outer tangs of the return spring 82*b;*

FIG. 11 is a sectional view of FIG. 10 in the plane indicated by the line 11—11 of FIG. 10 showing the engagement between the cover and upper retainer, and the plane of the view shown in FIG. 10 indicated by line 10—10;

FIG. 12 is a sectional view of FIG. 10 in the plane indicated by the line 12—12 of FIG. 10 showing the engagement between the inner shaft collar and lower retainer, and the plane of the view shown in FIG. 10 indicated by line 10—10; and

FIG. 13 is a sectional view of FIG. 10 in the plane indicated by the line 13—13 of FIG. 10 showing the arrangement of the components in the end of the support housing adjacent to the switch.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, numeral 10 generally indicates a remote control lever module of the present invention. The lever module 10 comprises a lever including an inner shaft 12, and an actuating arm 14 extending from the inner shaft at an angle thereto. A pedal 16 is connected to the actuating arm 14.

An intermediate bearing 18 coaxially surrounds a portion of the inner shaft 12. An outer shaft 20 coaxially surrounds a portion of the intermediate bearing 18 enabling relative rotation between the inner and outer shafts 12,20. The outer shaft 20 has an outer shaft stop 22 engageable with the inner shaft 12 to limit backward rotation, indicated by numeral 23, of the inner shaft 12 with respect to the outer shaft when the inner shaft engages the outer shaft stop thereby defining a rearmost position

A support means 24 includes an inner shaft bearing 25 which pivotably supports the inner shaft 12 so that, displacement of the actuating arm 14 causes the inner shaft 12 to rotate in a forward direction, indicated by numeral 26, or in a backward direction 23 about its axis. Displacement of the actuating arm 14 can be produced by the operator depressing the pedal 16 or releasing a depressed pedal. An outer shaft bearing 28 pivotably supports the outer shaft 20 enabling the outer shaft to forwardly or backwardly rotate 26,23 about its axis.

A return means 30 is engageable with the inner and outer shafts 12,20 enabling forward rotation 26 of the inner shaft to cause forward rotation of the outer shaft. The return means 30 further enables forward rotation 26 of the inner shaft 12 to cause forward rotation of the inner shaft away from the rearmost position. The return means 30 also urges the inner shaft 12 toward the rearmost position when the inner shaft has forwardly rotated 26 away from the rearmost position. The return means 30 limits backward rotation 23 of the outer shaft 20 beyond a nonactuating position, with the engagement between the inner shaft 12 and outer shaft stop 22 limiting backward rotation 23 of the inner shaft beyond the nonactuating position.

A force spring 32 has one end anchored to the outer shaft 20 and another end anchored to the support means 24. The force spring 32 urges the outer shaft 20 toward the nonactuating position when the outer shaft has forwardly rotated 26 away from the nonactuating position. The force spring 32 is sufficiently yielding so that rotation of the inner shaft 12 causes rotation of the outer shaft 20.

An inner shaft sensor 34 is connected to the support means 24 and is adapted to produce an electrical signal proportional to the angular displacement of the inner shaft 12 with respect to the support means. An outer shaft sensor 36 is connected to the support means 24 and is adapted to produce an electrical signal proportional to the angular displacement of the outer shaft 20 with respect to the support means.

More specifically, the inner shaft 12 includes a cylindrical inner shaft axle 38 with one end having a double D configuration in cross section for attachment of the actuating arm 14 thereto. The one end of the inner shaft axle 38 may also have screw threads. The other end of the inner shaft axle 38 also has a double D configuration in cross section for engagement with the inner shaft sensor 34. The inner shaft axle 38 has a flat 40 on its outer surface.

The inner shaft 12 includes an inner shaft collar 42 having an annular flange portion 44 press fitted to the inner shaft axle 38. The inner shaft collar 42 has a flat 46 on its inner surface which engages the flat 40 on the inner shaft axle 38 so that the inner shaft axle and inner shaft collar have a predetermined angular alignment with respect to one another. The inner shaft collar 42 has a cylindrical spacer portion 48 depending from the flange portion 44. The inner shaft collar 42 has an inner shaft stop 50 comprising an arcuate inner tab depending from the spacer portion 48. The inner shaft stop 50 defines a 180 degree arc. A longitudinal slot 51 extends through the inner shaft stop 50 and spacer portion 48. The longitudinal slot 51 is located midway between the ends of the inner shaft stop 50. The inner shaft collar 42 also has a cylindrical axle portion 49 depending from the flange portion 44 and press fitted onto the inner shaft axle 38. The axle portion 49 has an annular cross section which is uniform along its length. The flange portion 44 and axle portion 49 may also be molded with the inner shaft axle 38 as a single integral unit.

The intermediate bearing 18 is cylindrical and can be formed from a variety of materials that reduce friction caused by sliding contact between two surfaces. One such material is a thermoset plastic comprising 43%

graphite, 20% phenolic with the remaining 37% comprising illite, talc, zincite and carbon.

The outer shaft 20 includes a cylindrical outer shaft axle 53 with a hollow interior to fit over the intermediate bearing 18. The outer shaft axle 53 has a flat 52 on its outer surface. One end of the outer shaft axle 53 has diametrically opposed longitudinal prongs 54 extending therefrom for engagement with outer shaft sensor 36.

The outer shaft 20 includes an outer shaft collar 56 having an annular flange portion 58 press fitted thereto. The inner surface of the outer shaft collar 56 has a flat 61 which the flat 52 on the outer shaft axle 53 engages so that the outer shaft axle and outer shaft collar have a predetermined angular alignment with respect to one another. The outer shaft collar 56 has a cylindrical spacer portion 60 extending upward from the flange portion 58. The spacer portion 60 is also press fitted to the outer shaft axle 53. The flange portion 58 and spacer portion 60 may also be molded with the outer shaft axle 53 as a single integral unit.

The outer shaft stop 22 comprises an arcuate tab portion extending upward from the spacer portion 60 of the outer shaft collar 56. The outer shaft stop 22 defines a 154 degree arc. A longitudinal slot 62 is located 80 degrees from one end of the outer shaft stop 22 in the spacer portion 60.

The outer and inner shaft stops 22,50 mesh together so that they are contained in the same radial plane with respect to the inner and outer shaft axles 38,53. Since the total arc length of the outer and inner shaft stops 22,50 is 334 degrees, there is 26 degrees of rotational play between the inner and outer shafts 12,20. The maximum backward rotation 23 of the inner shaft 12, with respect to the outer shaft 20, is limited by the engagement of one end of the outer shaft stop 22 with one end of the inner shaft stop 50 and defines the rearmost position. The maximum forward rotation 26 of the inner shaft 12, with respect to the outer shaft 20, is limited by the engagement of the other end of the outer shaft stop 22 with the other end of the inner shaft stop 50 and defines the foremost position.

The return means 30 includes a return stop 63 comprising an arcuate tab portion depending from the flange portion 58 in the opposite direction from the spacer portion 60. The return stop 63 defines a 60 degree arc and is spaced 33.25 degrees from one end of the outer shaft stop 22. A longitudinal slot 64 is located midway between the ends of the return stop 63.

The support means 24 comprises a metallic support housing 65 having a cylindrical interior with circular openings at each end. A cover 66 is disposed over one end of the support housing 65 with the support housing being crimped over the cover to prevent removal of the cover therefrom. The support housing 65 has a support flange 68 parallel to the plane of the cover 66. The support flange 68 has three mounting holes for mounting the support housing 65 to a vehicle so that the support housing is stationary with respect to the seat of the operator.

The inner and outer shaft axles 38,53, and the inner and outer shaft collars 42,56 are located in the support housing 65. The inner shaft bearing 25 is disposed between the inner shaft axle 38 and support housing 65, and comprises a ball bearing.

The outer shaft bearing 28 is cylindrical and disposed between the outer shaft axle 53 and support housing 65. The outer shaft bearing 28 can be formed from a variety of materials that reduce friction caused by sliding contact between two surfaces One such material is a thermoset plastic comprising 43% graphite, 20% phenolic with the remaining 37% comprising illite, talc, zincite and carbon.

The end of the support housing 65 adjacent the outer shaft bearing 28 has inner and outer annular bosses 70,72 formed thereon. The longitudinal dimension of the inner boss 70 is less than the outer boss 72. The outer boss 72 has a radial slot 74.

The return means 30 comprises a return recess 76 formed in the outer boss 72. The return recess 76 has one end located 113.5 degrees from the radial slot 74, and defines a 61.5 degree arc, as shown in FIG. 6. The return stop 63 extends into the return recess 76 so that 1.5 degrees of rotational play is allowed between the return stop and support housing 65.

Backward rotation 23 of the outer shaft 20, with respect to the support housing 65, is limited by engagement of the return stop 63 with the rear end of the return recess 76 which constitutes a rear stop 78. The nonactuating position is defined by the angular position of the outer shaft 20 when the return stop 63 engages the rear stop 78 of the return recess 76. Forward rotation 26 of the outer shaft 20, with respect to the support housing 65, is limited by engagement of the return stop 63 with the front end of the return recess 76 which constitutes the front stop 80. The actuating position is defined by the angular position of the outer shaft 20 when the return stop 63 engages the front stop 80 of the return recess 76.

The return means 30 further includes a return spring 82 which may comprise a double coil helical or torsion spring. Each coil of the return spring 82 has a tang at one end which is inserted into the slot 51 in the inner shaft collar 42 to anchor the return spring to the inner shaft 12. The other end of each coil of the return spring 82 also has a tang which is inserted into the slot 62 in the outer shaft collar 56 to anchor the return spring to the outer shaft 20. The return spring 82 encircles the spacer portions 48,60 when anchored to the inner and outer shaft collars 42,56. The return spring 82 urges forward rotation 26 of the outer shaft 20 when the inner shaft 12 is forwardly rotated. The return spring 82 is sufficiently yielding so that, when the outer shaft 20 is in the actuating position, the return spring allows forward rotation 26 of the inner shaft 12 away from the rearmost position. The return spring 82 acts on the inner shaft 12 when it has forwardly rotated 26 away from the rearmost position to urge the inner shaft toward the rearmost position.

The return spring 82 preferably comprises a pair of spirally wound flat strip springs each having an inner and outer tang. The inner tangs are inserted into the slot 51 in the inner shaft collar 42. The outer tangs are hook-shaped in order to catch a tang member fixed to the flange portion 58 of the outer shaft collar 56. The tang member extends toward the flange portion 44 of the inner shaft collar 42 and is disposed between the two flange portions 44,58. The flat strip springs encircle the spacer portion 48 of the inner shaft collar 42. The flat strip springs act on the inner and outer shafts 12,20 in a similar manner as the return springs 82.

One end of the force spring 32 has a tang which is inserted into the slot 64 in the return stop 63 to anchor the force spring to the outer shaft 20. The other end of the force spring 32 has a tang which is inserted into the slot 74 in the outer boss 74 to anchor the force spring to the support housing 65. The force spring 32 is disposed

between the inner and outer bosses 70,72 when anchored to the outer shaft 20 and support housing 65. The stiffness of the force spring 32 is substantially less than the stiffness of the return spring 82.

It is possible to reverse the orientation of the slots 51,62,64,74 so that the direction of forward and backward rotation 26,23 of the inner and outer shafts 12,20 with respect to the support housing 65 is reversed. The support housing 65 has a second slot 74 in which the tang at the other end of the force spring 32 is inserted to facilitate such reversal.

The axle portion 49 of the inner shaft collar 42, and the outer shaft axle 53 are coaxially positioned end-to-end. A friction pad comprising a friction collar 83 includes a sleeve 84 formed of thermoplastic comprising an ETFE (ethylene tetrafluoroethylene) fluoropolymer with 10% glass. The sleeve 84 has a first friction surface which coaxially surrounds and engages the end of the outer shaft axle 53 adjacent to the axle portion 49. The sleeve 84 has a second friction surface which coaxially surrounds and engages the end of the axle portion 49 adjacent to the outer shaft axle 53.

Resilient collar rings 86 fit in grooves in the sleeve 84 to coaxially surround the sleeve. The collar rings 86 radially compress the sleeve 84 to cause the sleeve to grip the axle portion 49 and outer shaft axle 53. This results in the first friction surface frictionally resisting relative displacement between the sleeve 84 and outer shaft axle 53, and the second friction surface frictionally resisting relative displacement between the sleeve 84 and axle portion 49. The sleeve 84 thereby frictionally resists relative rotation between the inner and outer shafts 12,20.

It is possible for the second friction surface of the sleeve 84 to engage a support member other than the outer shaft axle 53, so long as the support member is fixed with respect to the support housing 65 during at least a portion of the rotation of the inner shaft 12. Such a support member could have an annular shape and extend from the support housing 65 in a coaxial orientation with respect to the inner shaft axle 38. It is also possible for the second friction surface of the sleeve 84 to directly engage the support housing 65.

A sensor housing 88 contains the inner and outer shaft sensors 34,36. The sensor housing 88 is bolted to the end of the support housing 65 opposite the cover 66 so that the ends of the inner and outer shaft axles 38,53 extend out of the support housing into the sensor housing to engage the inner and outer shaft sensors 34,36.

The outer shaft sensor 36 includes an annular member with diametrically opposed slots into which the prongs on the outer shaft axle 53 are inserted. Rotation of the outer shaft 20 causes the prongs 54 to engage the slots and cause the annular member to concomitantly rotate. The outer shaft sensor 36 includes an outer shaft sensor element which is connected to the annular member and thereby concomitantly rotates with the outer shaft 20. The outer shaft sensor element produces an electrical force signal proportional to the rotation of the annular member (which equals the rotation of the outer shaft 20) with respect to the support housing 65. The force signal produced when the outer shaft 20 is in the nonactuating position constitutes the nonactuating signal, and the force signal produced when the outer shaft is forwardly rotated 26 away from the nonactuating position constitutes the actuating signal. The force signal produced by the outer shaft sensor element preferably has an inversed polarity wherein its voltage output decreases as the outer shaft 20 forwardly rotates 26.

The outer shaft sensor 36a may alternatively comprise a switch 92 mounted on the rear stop 78a, as shown in FIGS. 7 and 8. Parts similar to those shown in FIGS. 1-6 have the same reference numeral with the addition of the suffix a. In this embodiment, the support housing 65a and sensor housing 88a are constituted by a single integral piece and plastic. The force switch 92 comprises first and second electrical contacts 94,95 comprising resilient conductive precision stampings which extend away from the rear stop 78a. The first and second electrical contacts 94,95 are insert molded into the rear stop 78a. The first and second contacts 94,95 are preferably formed from beryllium-copper and may be alternatively formed from phospher-bronze. switch leads 93 extend from the first and second contacts 94,95 through the support housing 65a and into the sensor housing 88a. The plastic material of which the support housing 65a and sensor housing 88a is formed results in the first and second contacts 94,95 and switch leads 93 being electrically isolated from one another.

The first contact 94 is resilient and extends further away from the rear stop 78a than the second contact 95 so that when the outer shaft 20a backwardly rotates 23 toward the rear stop 78a, the return stop 63a initially engages the first contact causing it to deflect. The first contact 94 is sufficiently stiff to considerably reduce the angular velocity of the return stop 63a thereby reducing the impact force of the return stop against the second contact 95. This can result in the first contact 94 being stiffer than the second contact 95.

The resiliency of the first contact 94 enables the outer shaft 20a to backwardly rotate 23 further into engagement with the second contact 95 so that the return stop 63a engages the first and second contacts 94,95 when the outer shaft is in the nonactuating position. Thus, the switch 92 is sandwiched between the rear stop 78a and the return stop 63a when the outer shaft 20a is in the nonactuating position.

The portion of the return stop 63a which engages the first and second contacts 94,95 is electrically conductive so that contact between them enables an electrical current to flow between the first and second contacts via the return stop to produce the nonactuating signal. Thus, the sandwiching results in the switch 92 producing the nonactuating signal.

The electrical current flow is interrupted when the outer shaft 20a is in the actuating position wherein the return stop 63a is disengaged from the first and second contacts 94,95. This causes the switch 92 to produce the actuating signal.

It is also possible for the outer shaft sensor 36 to comprise an annular member which concomitantly rotates with the outer shaft axle 53, as shown in FIG. 3, and a switch 92, as shown in FIGS. 7 and 8.

The inner shaft sensor 34 includes a cylindrical member concentric with the annular member of the outer shaft sensor 36 and longitudinally spaced apart from the support housing 65. The cylindrical member has radial detents which extend radially inward from its inner wall. The end of the inner shaft axle 38 extends into the cylindrical member between the radial detents so that rotation of the inner shaft causes the end of the inner shaft axle to engage the detents and produce concomitant rotation of the cylindrical member. A spring is connected to the cylindrical member to resist forward rotation 26 of the cylindrical member thereby causing

the cylindrical member to backwardly rotate 23 concomitantly with the inner shaft axle 38.

The inner shaft sensor 34 preferably includes two inner shaft resistive sensor elements which are connected to the cylindrical member and concomitantly rotate with the inner shaft 12. Each inner shaft sensor element produces an output voltage proportional to the rotation of the inner shaft 12 with respect to the support housing 65. The two inner shaft sensor elements have opposite polarities so that when rotation of the inner shaft 12 causes the output voltage of one inner shaft sensor element to increase, the output voltage of the other inner shaft sensor element decreases by an equal amount. The output voltages of the two inner shaft sensor elements constitute the electrical position signal.

For the embodiment wherein the outer shaft sensor 36 includes an outer shaft sensor element which produces a force signal proportional to the rotation of the outer shaft 20, the voltage output of the outer shaft sensor element equals the voltage output of the inner shaft sensor having an inversed polarity when the outer shaft is in the nonactuating position. The change in the magnitude of the voltage output of the outer shaft sensor element is substantially greater than the change in the magnitude of the voltage output of each inner shaft sensor element, assuming equal angular displacements of the inner and outer shafts 12, 20.

The sensor housing 88 has electronic circuitry to which leads (e.g., the switch leads 93) from the inner and outer shaft sensors 34,36 extend. The electronic circuitry is electrically connected to a connector socket 90 adapted to receive a connector which is electrically connected to an electronic control system for the engine. The electronic circuitry in the sensor housing 88 facilitates forwarding of the position and force signals to the electronic control system via the connector in the connector socket 90. The electronic control system is able to read the position and force signals.

In operation, when the operator depresses the pedal 16, the inner shaft 12 forwardly rotates 26. The forward rotation 26 of the inner shaft 12 is transmitted to the outer shaft 20 via the return spring 82. The outer shaft 20 forwardly rotates 26 away from the nonactuating position causing the return stop 63 to disengage from the rear stop 78 of the return recess 76. After the outer shaft 20 has rotated 1.5 degrees, the return stop 63 engages the front stop 80 of the return recess 76 which obstructs further forward rotation 26 of the outer shaft 20 with the outer shaft being in the actuating position. During the forward rotation 26 of the outer shaft 20, the inner shaft 12 rotates very little with respect to the outer shaft 20 since the return spring 82 is substantially stiffer than the force spring 32.

Continued rotation of the inner shaft 12 by depression of the pedal 16 causes the inner shaft to forwardly rotate 26 away from the rearmost position with the inner shaft stop 50 disengaging from the outer shaft stop 22. The friction collar 83 resists relative rotation of the inner shaft 12 with respect to the outer shaft 20.

The inner and outer shaft sensors 34,36 measure the angular displacement of the inner and outer shafts, 12,20, respectively, with the degree of opening of the engine throttle valve normally being proportional to the angular displacement of the inner shaft 12.

When depression of the pedal 16 ceases, the return spring 82 urges the inner shaft collar 42 to backwardly rotate 23, with respect to the outer shaft 20, toward the rearmost position. When the inner shaft 12 reaches the rearmost position, the inner shaft stop 50 engages the outer shaft stop 22 preventing further backward rotation 23 of the inner shaft with respect to the outer shaft 20. The force spring 32 then urges the outer shaft collar 56 to backwardly rotate 23 from the actuating to nonactuating positions. The return spring 82 causes the backward rotation 23 of the outer shaft 20 to be transmitted to the inner shaft 12.

Deviations from the above sequence are sensed by the inner and outer shaft sensors 34,36 and detected by the electronic control system. Deviations can indicate that an examination of the lever module 10 is warranted.

The electronic control system is also able to detect inconsistencies between the output voltages produced by the inner shaft sensor elements of the inner shaft sensor 34. The opposite polarities of the inner shaft sensor elements, and the different rates at which the output voltages change, facilitate detection of some inconsistencies. Such inconsistencies can indicate that an examination of the lever module 10, and in particular, the inner shaft sensor 34, is warranted. The position signal also enables the electronic control system to detect the angular displacement of the inner shaft 12 and control the engine in accordance therewith.

The electronic control system is further able to detect inconsistencies between the actuating/nonactuating signals produced by an outer shaft sensor 36 comprising an annular member which concomitantly rotates with the outer shaft axle 53 and a switch 92. Such inconsistencies can indicate that an examination of the lever module 10, and in particular, the outer shaft sensor 36, is warranted.

It is possible to construct the lever module 10, 10*a* so that the maximum angular displacement of the inner shaft 12, 12*a* is less than the maximum angular displacement of the outer shaft 20, 20*a*, and the actuating arm 14, 14*a* is connected to the outer shaft and not the inner shaft. The degree of opening of the engine throttle valve would thereby be proportional to the angular displacement of the outer shaft 20, 20*a*.

Second Embodiment

FIGS. 9-13 show an alternative embodiment of the lever module 10*b*. Parts similar to those shown in FIGS. 1-8 have the same reference numeral with the addition of the suffix b. In this embodiment, inner shaft bearings 25*b* comprising sealed ball bearings support the inner shaft at opposite ends of the support housing 65*b*. The outer race of the upper inner shaft bearing 25*b* is held in the cover 66*b* by a press fit. The outer race of the lower inner shaft bearing 25*b* is held in the support housing 65*b* by a press fit. The inner diameters of the inner races of both inner shaft bearings 25*b* are larger than the cross sections of the respective portions of the inner shaft axle 38*b* which extend through them. Each inner shaft bearing 25*b* has a pair of annular rubber members which extend between the inner and outer races with one rubber member being above and the other rubber member being below the balls in the bearing.

The inner shaft 12*b* includes a stainless steel inner shaft axle 38*b* and a die cast aluminum inner shaft collar 42*b*. The inner shaft collar 42*b* is preferably insert molded around the inner shaft axle 38*b*, with the two parts being machined as a single assembly. The inner shaft collar 42*b* can alternatively be held to the inner shaft axle by a press fit. The inner shaft collar 42*b* has an annular flange portion 44*b* and a cylindrical axle portion 49*b* extending upward therefrom. The inner shaft collar

42b has an inner shaft stop 50b comprising an arcuate inner tab depending from the flange portion 44b. The inner shaft stop 50b defines a 152.5 degree arc. A longitudinal slot 51b extends through the inner shaft stop 50b and spacer portion 48b.

The return means 30b comprises a pair of arcuate return recesses 76b formed in the end of the support housing 65b adjacent to the sensor housing 88b, as shown in FIG. 13. Each return recess 76b defines a 180 degree arc. The inner shaft stop 50b extends into one of the return recesses 76b so that 27.5 degrees of rotational play is allowed between the inner shaft stop and support housing 65b.

Backward rotation of the inner shaft 10b, with respect to the support housing 65b, is limited by engagement of the inner shaft stop 50b with the rear end of the one return recess 76b which constitutes the rear stop 78b. The rearmost position is defined by the angular position of the inner shaft 10b when the inner shaft stop 50b engages the rear stop 78b of the return recess 76b. Forward rotation of the inner shaft 10b, with respect to the support housing 65b, is limited by engagement of the inner shaft stop 50b with the front end of the one return recess 76b which constitutes the front stop 80b. The actuating position is defined by the angular position of the inner shaft 10b when inner shaft stop 50b is rotated away from the rear stop 78b.

The return means 30b includes a return spring 82b comprising a pair of spirally wound flat metal strip springs, as shown in FIGS. 10 and 12. Each coil of the return spring 82b has an inner tang at one end which is inserted into the slot 51b in the inner shaft collar 42b to anchor the return spring to the inner shaft 12b. The return spring 82b encircles the inner shaft collar 42b when anchored to it. The other end of each coil of the return spring 82b has an outer tang which is inserted into a housing slot 110 in the support housing 65b to anchor the return spring thereto. The return means 30b includes a plastic or metal spring washer 118 disposed between the strip springs of the return spring 82b. The spring washer 118 has an axial opening which is larger than the portion of the inner shaft collar 42b which extends through it. The return spring 82b acts on the inner shaft 12b when it has forwardly rotated away from the rearmost position to urge the inner shaft toward the rearmost position. The support housing 65b has a second housing slot 110 in which the outer tang of the return spring 82b can be inserted enabling reversal of the directions of forward and backward rotation 26b,23b with respect to the support housing.

The end of the inner shaft collar 42b opposite to the sensor housing 88b has a pair of cylindrical collar keyways 112 with each collar keyway having an axis which is parallel to the inner shaft axle 38b, as shown in FIG. 12.

The inner shaft 12b includes a shaft retainer 114 comprising a disk which frictionally resists rubbing against an adjoining surface. Possible materials for the disk of the shaft retainer 114 include metal, plastic including phenolic and glass filled plastic, or materials similar to those used for conventional brake pads or clutch liners. The material of which the disk of the shaft retainer 114 is formed should have dimensional stability (i.e., be formable in accordance with precise specifications), high compressive strength, high coefficient of friction, and the ability to withstand high temperatures. Possible materials for the shaft retainer 114 includes Lexan 121 and Noryl 731 with 0%, 20% and 30% glass-fillings, powder metallurgy parts with or without EDM patterns, and coated metal parts.

The shaft retainer 114 has a shaft axial opening 116 through which the inner shaft axle 38b extends. The shaft axial opening 116 has a cross section which is larger than the cross section of the portion of the inner shaft axle 38b which extends through it. The shaft retainer 114 has a pair of downwardly extending collar pins 120 which extend into the collar keyways 112 to key the shaft retainer to the inner shaft collar 42b, as shown in FIGS. 10 and 12. The collar pins 120 are held in the collar keyways 112 by a press fit. Relative rotation between the shaft retainer 114 and inner shaft collar 42b is thereby obstructed. The shaft retainer 114 has a first retainer surface 122 opposite the collar pins 120 in a plane perpendicular to the axis of the inner shaft axle 38b.

The plastic cover 66b is staked to the one-piece plastic support housing 65b by vibration or sonic welding. The cover 66b includes an interior end surface 124 which has a pair of arcuate cover flanges 126 which extend inwardly along the axis of the inner shaft axle 38b, as shown in FIGS. 10 and 11.

The support means 24b includes a support member 128 comprising a disk formed of a material included in the group of possible materials described above for the disk of the shaft retainer 114. The support member 128 has a support axial opening 130 through which the inner shaft axle 38b extends. The support axial opening 130 has a cross section which is larger than the cross section of the portion of the inner shaft axle 38b which extends through it.

The support member 128 has a pair of upwardly extending support pins 132 which extend into the spaces between the cover flanges 126, as shown in FIGS. 10 and 11. The cross section of each support pin 132 corresponds to space between the cover flanges 126 to key the support member 128 to the cover 66b. Relative rotation between the support member and cover 66b is thereby obstructed. Axial displacement of the support member 128 with respect to the cover 66b is allowed.

The support member 128 has a second retainer surface 134 which faces the first retainer surface 122 in a plane parallel thereto. The support member 128 has a spring surface 136 which faces the end surface 124 in a plane parallel thereto.

A friction pad 138 comprising upper and lower pads 140,142 is disposed between the shaft retainer 114 and support member 128. The upper and lower pads 140,142 are formed of a material included in the group of possible materials described above for the disk of the shaft retainer 114. The material of the upper pad 140 differs from the material of the second retainer surface 134 and the material of the lower pad 142, and the material of the lower pad 142 differs from the material of the first retainer surface 122. This arrangement, wherein different materials adjoin one another, may be achieved by forming the support member 128 and lower pad 142 of the same material, and the upper pad 140 and shaft retainer 114 of the same material, wherein the material of the upper pad 140 differs from the material of the lower pad 142. The materials of the upper and lower pads 140, 142, and the first and second retainer surfaces 122, 134 can be selected so that relative displacement between predetermined pairs of adjoining surfaces occurs when predetermined torques are applied to the inner shaft 12b, with the torque being proportional to the force applied to the pedal 16b.

The friction pad 138 has a pad axial opening 144 through which the inner shaft axle 38b extends. The pad axial opening 144 has a cross section which is larger than the cross section of the portion of the inner shaft axle 38b which extends through it. The friction pad 138 has a first friction surface 146 which engages the first retainer surface 122 and a second friction surface 148 which engages the second retainer surface 134.

The support member 128 includes a pair of washers comprising Belleville springs 150 having a back-to-back orientation with respect to one another disposed between the end and spring surfaces 124,136, as shown in FIG. 10. The Belleville springs 150 urge the support member 128 in the axial direction into engagement with the friction pad 138. This results in the friction pad 138 being resiliently compressed between the support member 128 and shaft retainer 118. The life and durability of the friction pad 138, support member 128 and shaft retainer 118 are inversely proportional to the compressive forces to which they are subjected. However, it is desirable for the compressive forces to be sufficiently large to maintain the friction pad 138, support member 128 and shaft retainer 118 in contact with one another since separation between them can allow them to vibrate.

A switch 92b is mounted on the rear stop 78b, as shown in FIGS. 10 and 13. The portion of the inner shaft stop 50b which engages the first and second contacts 94b,95b is electrically conductive so that contact between them enables an electrical current to flow between the first and second contacts via the inner shaft stop to produce the nonactuating signal. Thus, the sandwiching results in the switch 92b producing the nonactuating signal.

The electrical current flow is interrupted when the inner shaft 12b is forwardly rotated away from the rearmost position wherein the inner shaft stop 50b is disengaged from the first and second contacts 94b,95b. This causes the force switch 92b to produce the actuating signal.

An inner shaft sensor 34b is connected to the support means 24b and is adapted to produce an electrical signal proportional to the angular displacement of the inner shaft 12b with respect to the support means. The inner shaft sensor 34b preferably includes two inner shaft sensor elements, as described above with respect to inner shaft sensor 34.

In operation, when the operator depresses the pedal 16b, the inner shaft 12b forwardly rotates 26b away from the rearmost position causing the inner shaft stop 50b to disengage from the force switch 92b. The friction pad 138 resists relative rotation of the inner shaft 12b with respect to the support means 24b. The inner shaft sensor 34b produces a position signal proportional to the angular displacement of the inner shaft 12b. The position signal is detected by the electronic control system which normally controls the engine in accordance with the position signal. The force switch 92b produces an actuating signal when the inner shaft stop 50b is disengaged from it.

When depression of the pedal 16b ceases, the return spring 82b urges the inner shaft collar 42b to backwardly rotate 23 toward the rearmost position. When the inner shaft 12b reaches the rearmost position, the inner shaft stop 50b engages the force switch 92b. The switch 92b produces a nonactuating signal when the inner shaft stop 50b is engaged with it.

The actuating/nonactuating signal produced by the switch 92b is also detected by the electronic control system. Inconsistencies between the actuating/nonactuating and position signals can indicate that an examination of the lever module 10b is warranted. Also, inconsistencies between the output voltages produced by the two inner shaft sensor elements can indicate that an examination of the lever module 10, and in particular, the inner shaft sensor 34b, is warranted.

Alternative embodiments of the lever module 10,10a,10b can also be used with a vehicle driven by an electric motor instead of an engine wherein the electric signals produced by the inner shaft sensor 34,34a,34b, outer shaft sensor 36 and switches 92,92b are used to control the output of the electric motor. Moreover, the lever module 10,10a,10b can be used in other applications to sense the movement of a lever.

While the invention has been described by reference to certain preferred embodiments, it should be understood that numerous changes could be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the disclosed embodiments, but that it have the full scope permitted by the language of the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A remote control lever module comprising:

a lever including an inner shaft, and an actuating arm extending from said inner shaft at an angle thereto;

an intermediate bearing coaxially surrounding a portion of said inner shaft;

an outer shaft coaxially surrounding a portion of said intermediate bearing enabling relative rotation between said inner and outer shafts, said outer shaft having an outer shaft stop engageable with said inner shaft to limit rotation in a backward direction of said inner shaft with respect to said outer shaft when said inner shaft is in a rearmost position;

a support means including an inner shaft bearing which pivotably supports said inner shaft so that, displacement of said actuating arm causes said inner shaft to rotate in a forward or backward direction about its axis, and an outer shaft bearing which pivotably supports said outer shaft enabling said outer shaft to forwardly or backwardly rotate about its axis;

a return means engageable with said inner and outer shafts enabling forward rotation of said inner shaft to cause forward rotation of said outer shaft, said return means further enabling forward rotation of said inner shaft to cause forward rotation of said inner shaft away from said rearmost position, said return means being adapted to urge said inner shaft toward said rearmost position when said inner shaft has forwardly rotated away from said rearmost position, said return means limiting backward rotation of said outer shaft beyond a nonactuating position, said engagement between said inner shaft and outer shaft stop limiting backward rotation of said inner shaft beyond said nonactuating position;

a force spring having one end anchored to said outer shaft and another end anchored to said support means, said force spring being adapted to urge said outer shaft toward said nonactuating position when said outer shaft has forwardly rotated away from said nonactuating position, said force spring being

sufficiently yielding so that forward rotation of said inner shaft causes forward rotation of said outer shaft;

an inner shaft sensor connected to said support means and engageable with said inner shaft, said inner shaft sensor being adapted to produce an electrical position signal proportional to the angular displacement of said inner shaft with respect to said support means; and

an outer shaft sensor connected to said support means and engageable with said outer shaft, said outer shaft sensor being adapted to produce an electrical nonactuating signal when said outer shaft is in said nonactuating position and an electrical actuating signal when said outer shaft is forwardly rotated away from said nonactuating position.

2. A remote control lever module as set forth in claim 1 wherein said return means comprises a return spring having one end anchored to said inner shaft and another end anchored to said outer shaft, said return spring being adapted to urge forward rotation of said outer shaft when said inner shaft is forwardly rotated, said return means further comprising a return stop connected to said outer shaft and engageable with said support means to limit forward rotation of said outer shaft beyond an actuating position, said return spring being sufficiently yielding so that, when said outer shaft is in said actuating position, said return spring allows forward rotation of said inner shaft away from said rearmost position, said return spring acting on said inner shaft when it has forwardly rotated away from said rearmost position to urge said inner shaft toward said rearmost position.

3. A remote control lever module as set forth in claim 1, and further comprising a friction collar gripping said inner and outer shafts to frictionally resist relative rotation between said inner and outer shafts.

4. A remote control lever module as set forth in claim 1 in combination with an electronic control system for a vehicle wherein said support means is attached to the vehicle so that it is stationary with respect to the seat of the driver, said actuating arm having a pedal connected thereto enabling said actuating arm to be actuated by a driver stepping on the pedal.

5. A remote control lever module as set forth in claim 1 wherein said outer shaft sensor is rotatably connected to said outer shaft.

6. A remote control lever module as set forth in claim 5 wherein said outer shaft sensor is further adapted to produce an electrical signal proportional to the angular displacement of said outer shaft with respect to said support means.

7. A remote control lever module as set forth in claim 1 wherein said return means comprises a rear stop formed on said support means so that said outer shaft engages said rear stop when said outer shaft is in said nonactuating position, and wherein said outer shaft sensor comprises a switch mounted on said rear stop so that, when said outer shaft is in said nonactuating position, said switch is sandwiched between said rear stop and said outer shaft, said switch being adapted so that said sandwiching causes said switch to produce said nonactuating signal, said switch being sized so that, when said outer shaft is forwardly rotated away from said nonactuating position, said outer shaft is disengaged from said switch, said switch being adapted so that said disengagement causes said switch to produce said actuating signal.

8. A remote control lever module as set forth in claim 7 wherein said switch comprises first and second electrical contacts extending from said rear stop, said outer shaft engaging said first and second contacts when said outer shaft is in said nonactuating position, the portion of said outer shaft which engages said first and second contacts being electrically conductive so that contact between them enables an electrical current to flow between said first and second contacts via said outer shaft to produce said nonactuating signal, said electrical current flow being interrupted when said outer shaft is in said actuating position wherein said outer shaft is disengaged from said first and second contacts thereby causing said switch to produce said actuating signal.

9. A remote control lever module as set forth in claim 8 wherein said first contact is resilient and extends further away from said rear stop than said second contact so that when said outer shaft backwardly rotates toward said rear stop, said outer shaft initially engages said first contact causing it to deflect thereby enabling said outer shaft to backwardly rotate further into engagement with said second contact thereby enabling said outer shaft to engage said second contact so that said outer shaft engages said first and second contact ends when in said nonactuating position.

10. A remote control lever module comprising:

a lever including an inner shaft, and an actuating arm extending from said inner shaft at an angle thereto;

a support means including an inner shaft bearing which pivotably supports said inner shaft so that, displacement of said actuating arm causes said inner shaft to rotate in a forward or backward direction about its axis;

a return means including a rear stop formed on said support means, said inner shaft being engageable with said rear stop to limit backward rotation of said inner shaft beyond a rearmost position, said return means being adapted to urge said inner shaft toward said rearmost position when said inner shaft has forwardly rotated away from said rearmost position;

an inner shaft sensor connected to said support means and engageable with said inner shaft, said inner shaft sensor being adapted to produce an electrical position signal proportional to the angular displacement of said inner shaft with respect to said support means; and

a switch mounted on said rear stop so that, when said inner shaft is in said rearmost position, said switch is sandwiched between said rear stop and inner shaft, said force switch being adapted so that said sandwiching causes said force switch to produce an electrical nonactuating signal, said switch being sized so that, when said inner shaft is forwardly rotated away from said rearmost position, said inner shaft is disengaged from said switch, said switch being adapted so that said disengagement causes said switch to produce an electrical actuating signal.

11. A remote control lever module as set forth in claim 10 wherein said switch comprises first and second electrical contacts extending from said rear stop, said inner shaft engaging said first and second contacts when said inner shaft is in said rearmost position, the portion of said inner shaft which engages said first and second contacts being electrically conductive so that contact between them enables an electrical current to flow between said first and second contacts via said inner shaft

to produce said nonactuating signal, said electrical current flow being interrupted when said inner shaft is forwardly rotated away from said rearmost position wherein said inner shaft is disengaged from said first and second contacts thereby causing said switch to produce said actuating signal.

12. A remote control lever module as set forth in claim 11 wherein said first contact is resilient and extends further away from said rear stop than said second contact so that when said inner shaft backwardly rotates toward said rear stop, said inner shaft initially engages said first contact causing it to deflect thereby enabling said inner shaft to backwardly rotate further into engagement with said second contact thereby enabling said inner shaft to engage said second contact so that said inner shaft engages said first and second contacts ends when in said rearmost position.

13. A remote control lever module as set forth in claim 10 in combination with an electronic control system for a vehicle wherein said support means is attached to the vehicle so that it is stationary with respect to the seat of the driver, said actuating arm having a pedal connected thereto enabling said actuating arm to be actuated by a driver stepping on the pedal.

14. A remote control lever module comprising:

a lever including an inner shaft, and an actuating arm extending from said inner shaft at an angle thereto;

a support means including an inner shaft bearing which pivotably supports said inner shaft so that, displacement of said actuating arm causes said inner shaft to rotate in a forward or backward direction about its axis, said support means including a support member which is fixed to said support means during at least a portion of said rotation of said inner shaft;

a return means engageable with said inner shaft to limit backward rotation of said inner shaft beyond a rearmost position, said return means being adapted to urge said inner shaft toward said rearmost position when said inner shaft has forwardly rotated away from said rearmost position;

a friction pad disposed between said inner shaft and said support member, said friction pad being adapted to rotate about the axis of said inner shaft with respect to said inner shaft and support member, said friction pad having a first friction surface in engagement with said inner shaft to frictionally resist relative displacement between said friction pad and said inner shaft, said friction pad having a second friction surface in engagement with said support member, said second friction surface frictionally resisting relative displacement between said friction pad and said support member; and

an inner shaft sensor connected to said support means and engageable with said inner shaft, said inner shaft sensor being adapted to produce an electrical position signal proportional to the angular displacement of said inner shaft with respect to said support means.

15. A remote control lever module as set forth in claim 14 wherein the portion of said friction pad which constitutes said first friction surface is formed of a first material, the portion of said inner shaft which engages said first friction surface is formed of a second material, said first material differing from said second material.

16. A remote control lever module as set forth in claim 14 wherein the portion of said friction pad which constitutes said second friction surface is formed of a first material, the portion of said support member which engages said second friction surface is formed of a second material, said first material differing from said second material.

17. A remote control lever module as set forth in claim 14 wherein said support member has an annular shape, said support member being coaxial with said inner shaft, and said friction pad comprises a friction collar coaxially surrounding said inner shaft and support member, the portions of said friction collar in engagement with said inner shaft and support member constituting said first and second friction surfaces, respectively, said friction collar being adapted to resiliently grasp said inner shaft and support member to cause said frictional resistance.

18. A remote control lever module as set forth in claim 14 wherein said inner shaft includes a shaft retainer keyed thereto so that said shaft retainer rotates concomitantly with said inner shaft, said shaft retainer having a first retainer surface in a plane perpendicular to the axis of said inner shaft;

said support member having a second retainer surface which faces said first retainer surface in a plane parallel thereto, said support member being keyed to said support means to obstruct rotation of said second retainer surface about said inner shaft with respect to said support means;

said friction pad comprising a disk having a pad axial opening through which said inner shaft extends, said pad axial opening having a cross section which is larger than the cross section of the portion of said inner shaft which extends through it, said friction pad being disposed between said shaft retainer and support member so that said first friction surface engages said first retainer surface and said second friction surface engages said second retainer surface;

said shaft retainer and support member being adapted to resiliently compress said friction pad to cause said frictional resistance.

19. A remote control lever module as set forth in claim 17 wherein said inner shaft is adapted to obstruct displacement of said shaft retainer away from said friction pad in said axial direction, said support means including an end surface which faces said support member in a plane perpendicular to the axis of said inner shaft, said support member comprising a disk having a support axial opening through which said inner shaft extends, said support axial opening having a cross section which is larger than the cross section of the portion of said inner shaft which extends through it, said support member further comprising a spring surface which faces said end surface in a plane parallel thereto, said support member further comprising a Belleville spring disposed between said end and spring surfaces to urge said support member into engagement with said friction pad so that said friction pad is resiliently compressed.

20. A remote control lever module as set forth in claim 14 in combination with an electronic control system for a vehicle wherein said support means is attached to the vehicle so that it is stationary with respect to the seat of the driver, said actuating arm having a pedal connected thereto enabling said actuating arm to be actuated by a driver stepping on the pedal.

21. A remote control lever module comprising:

a lever including an inner shaft, and an actuating arm extending from said inner shaft at an angle thereto;

a support means including an inner shaft bearing which pivotably supports said inner shaft so that, displacement of said actuating arm causes said inner shaft to rotate in a forward or backward direction about its axis;

a return means engageable with said inner shaft to limit backward rotation of said inner shaft beyond a rearmost position, said return means being adapted to urge said inner shaft toward said rearmost position when said inner shaft has forwardly rotated away from said rearmost position;

a friction pad disposed between said inner shaft and said support means, said friction pad having a first friction surface in engagement with said inner shaft to frictionally resist relative displacement between said friction pad and said inner shaft;

a Belleville spring disposed between said support means and friction pad to urge said friction pad into engagement with said inner shaft to cause said frictional resistance; and

an inner shaft sensor connected to said support means and engageable with said inner shaft, said inner shaft sensor being adapted to produce an electrical position signal proportional to the angular displacement of said inner shaft with respect to said support means.

22. A remote control lever module as set forth in claim 21 in combination with an electronic control system for a vehicle wherein said support means is attached to the vehicle so that it is stationary with respect to the seat of the driver, said actuating arm having a pedal connected thereto enabling said actuating arm to be actuated by a driver stepping on the pedal.

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United States Patent [19]

Riggle

[11] Patent Number: 5,887,488

[45] Date of Patent: Mar. 30, 1999

[54] VEHICULAR ACCELERATOR PEDAL APPARATUS

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[73] Assignee: IMO Industries, Inc., Hudson, Ohio

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[51] Int. Cl.[6] G05G 1/14

[52] U.S. Cl. 74/514; 123/399

[58] Field of Search 74/514, 513, 560; 123/399; 180/335; 338/153, 47, 108, 113

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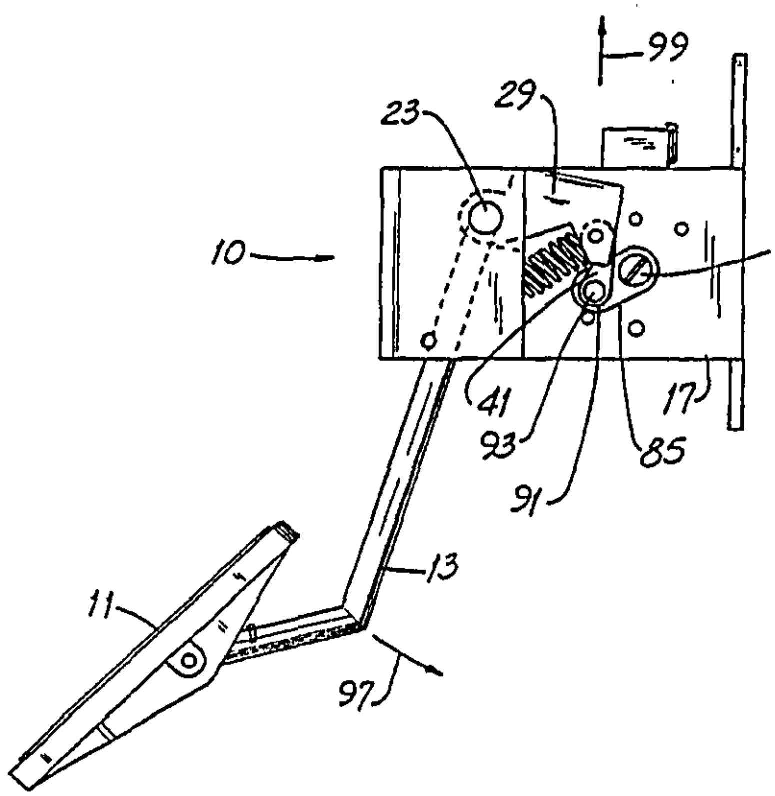
[57] ABSTRACT

A vehicular accelerator pedal apparatus for electronic control of vehicle engine speed. The apparatus has a pedal position sensor with a rotatable stem, an accelerator pedal and an actuator bar extending from the pedal toward the sensor mounting bracket. In the improvement, the actuator bar is connected to a drive shaft which is pivot-mounted on the bracket. An actuator linkage is coupled to and pivoted by the drive shaft and extends between such the drive shaft and the sensor stem. The linkage includes first and second links imparting rotary motion to the stem when the linkage is pivoted by movement of the pedal. The second link is available in several different lengths and the apparatus thereby accommodates each of several different sensors by using a second link having the length appropriate for a particular sensor.

12 Claims, 10 Drawing Sheets



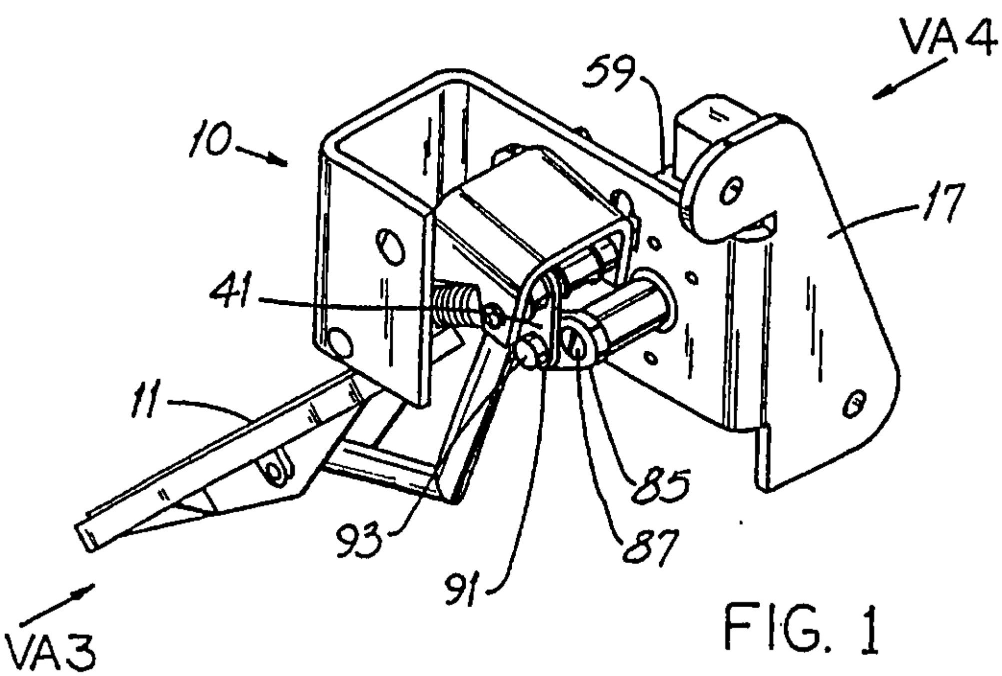


FIG. 1

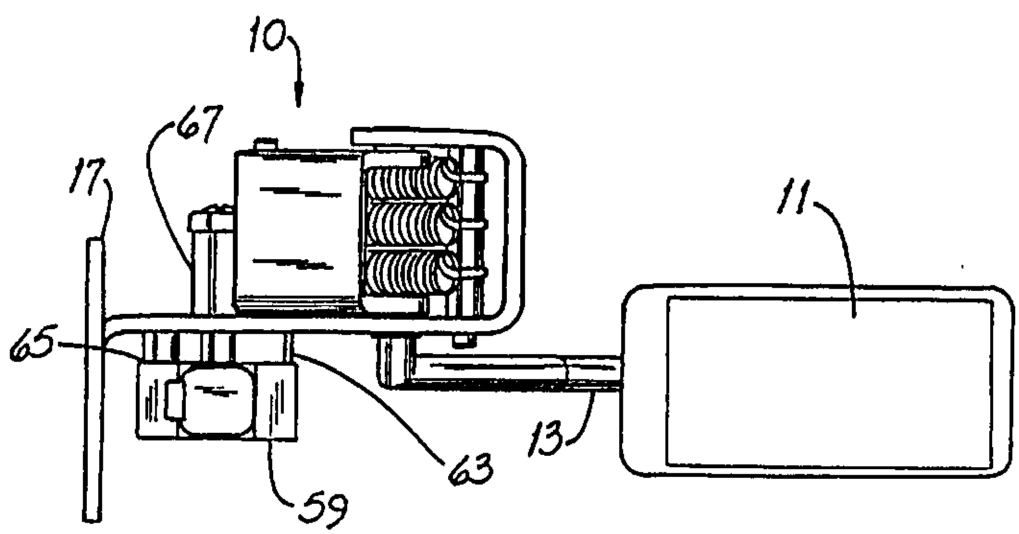


FIG. 5

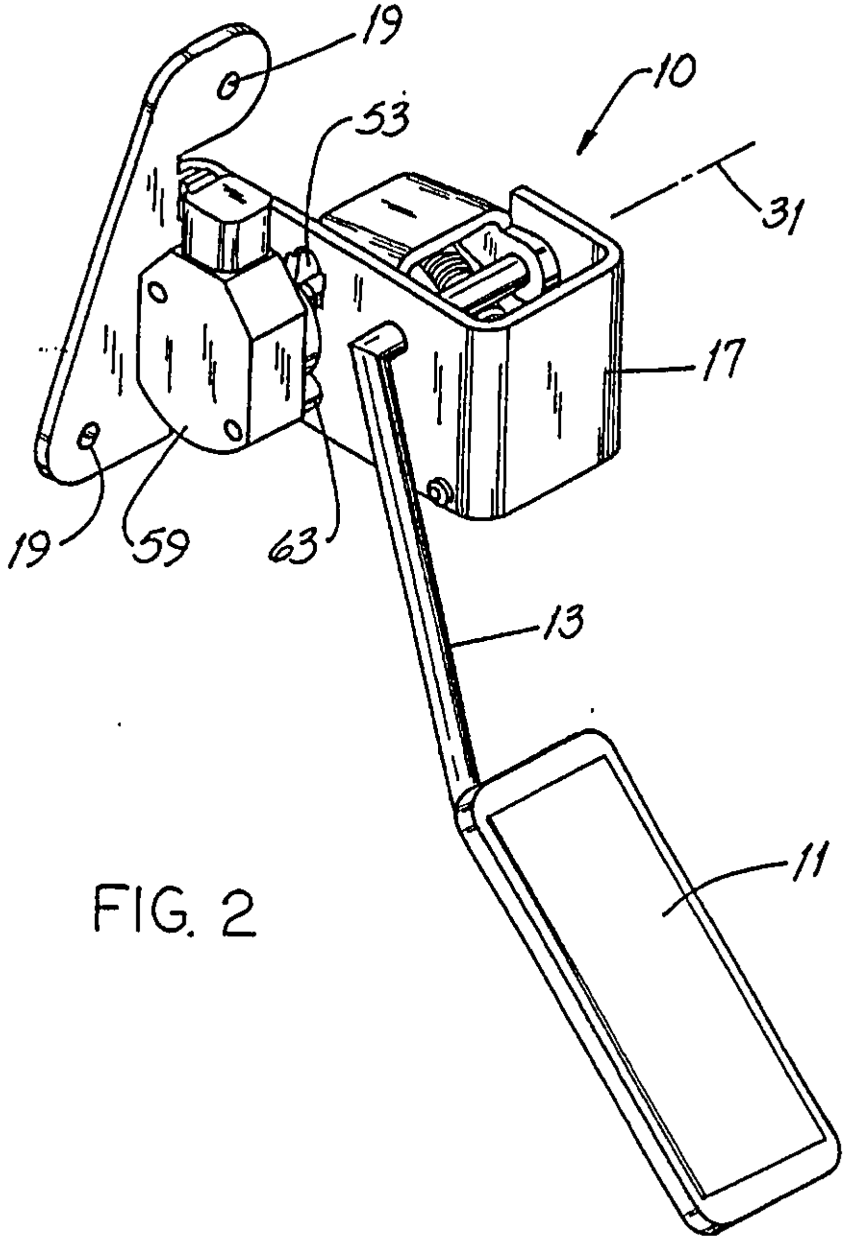


FIG. 2

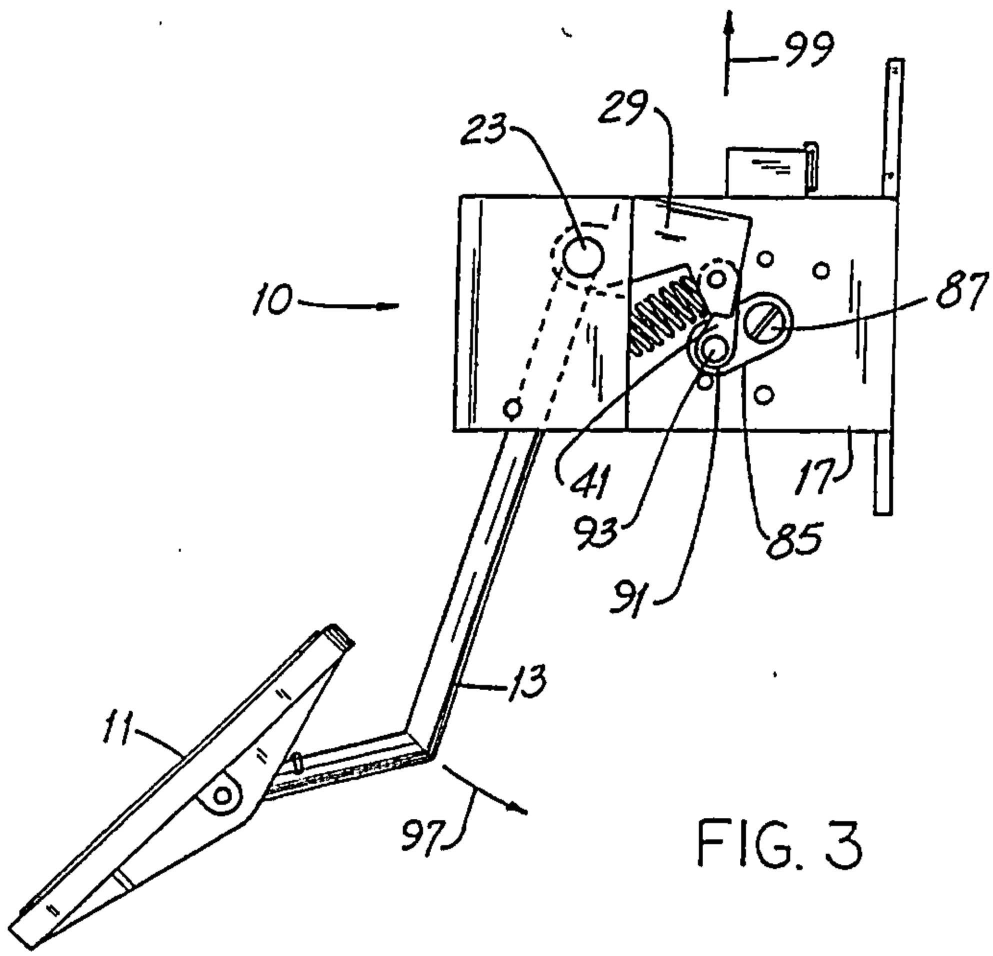


FIG. 3

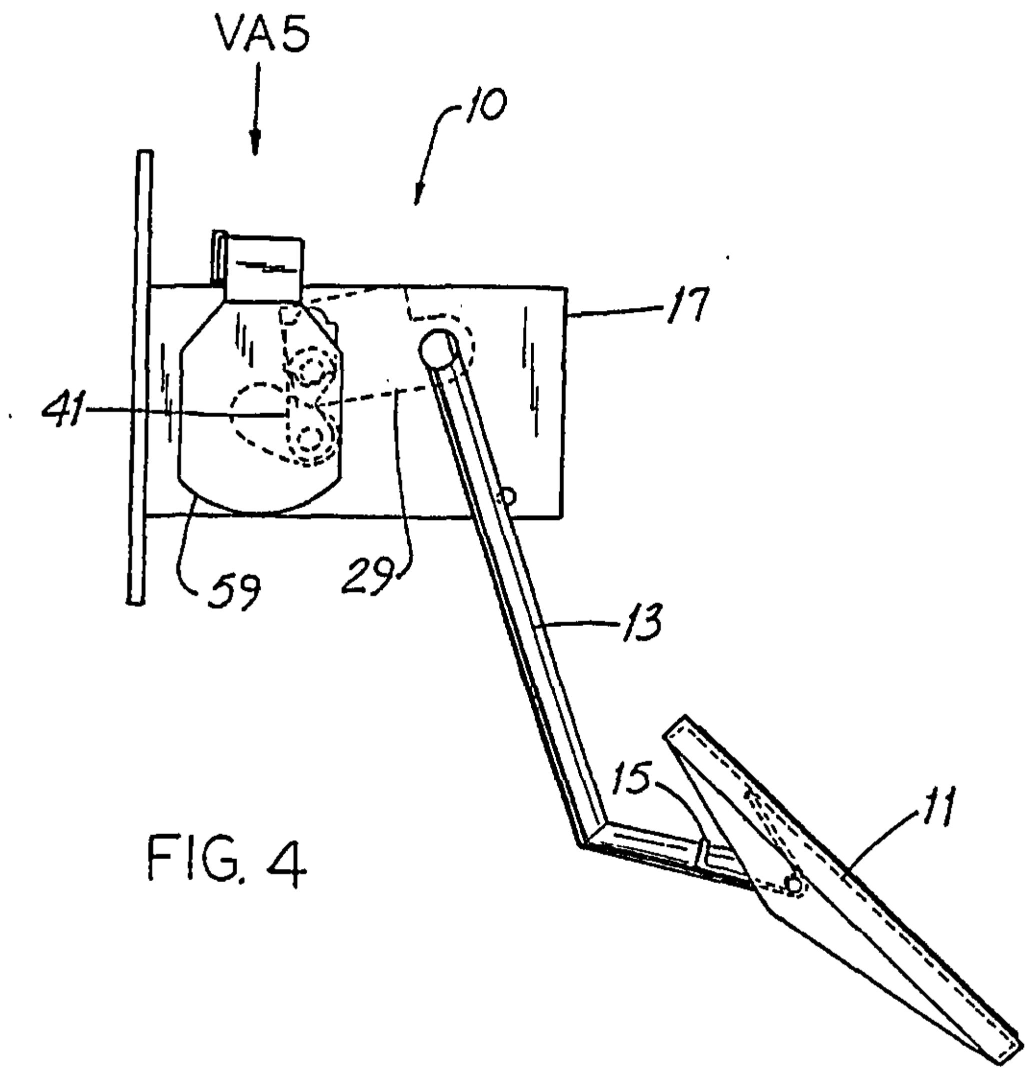
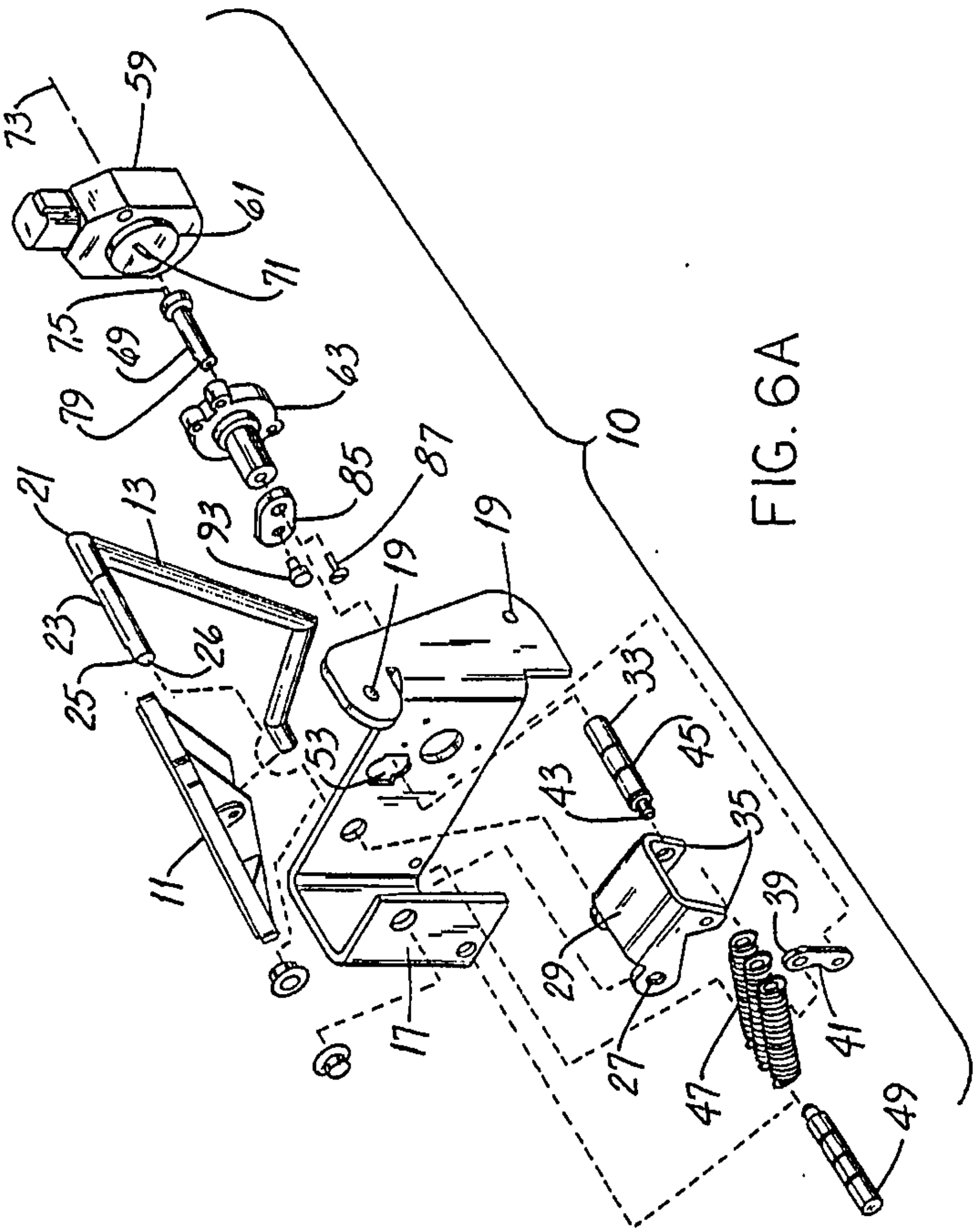


FIG. 4



73
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FIG. 6A

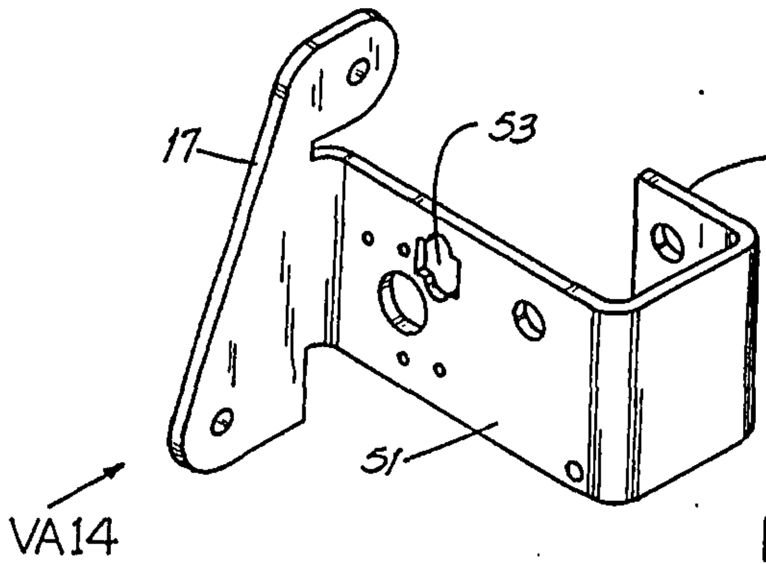

FIG. 13

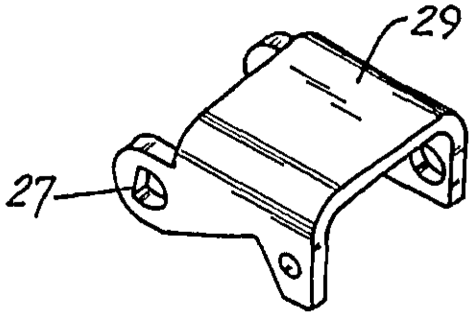

FIG. 6B

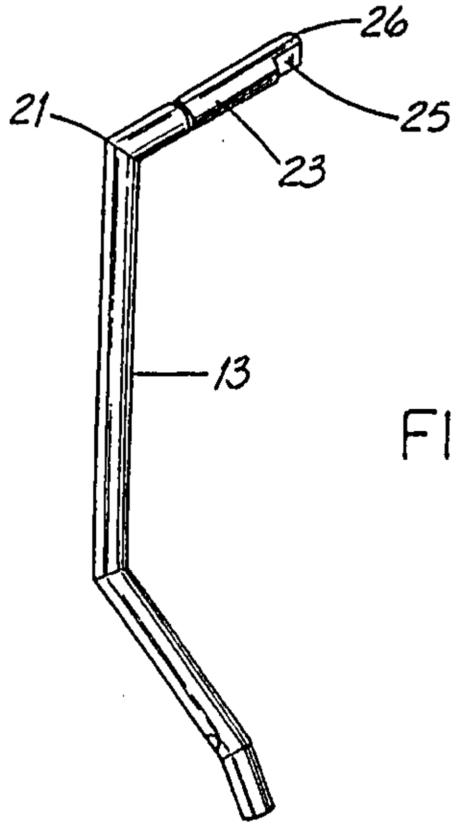

FIG. 7

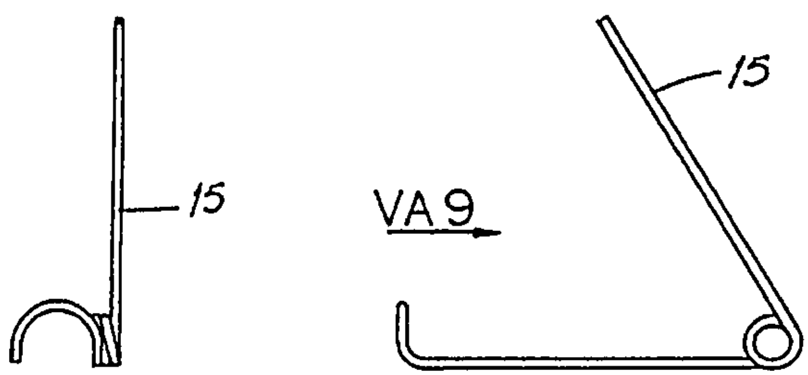

FIG. 9

FIG. 8

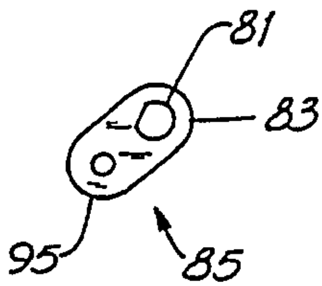

FIG. 18

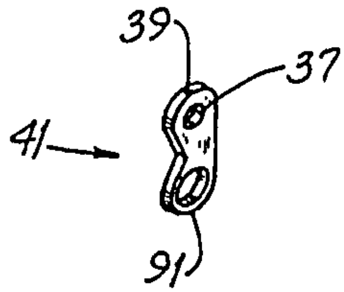

FIG. 12

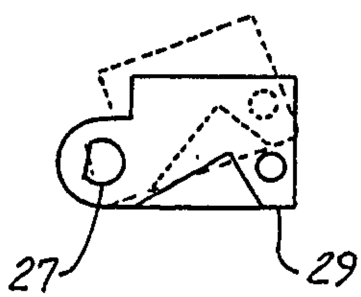

FIG. 10

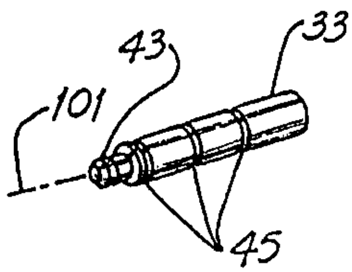

FIG. 11

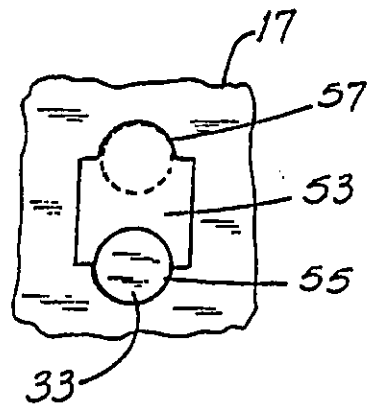

FIG. 14

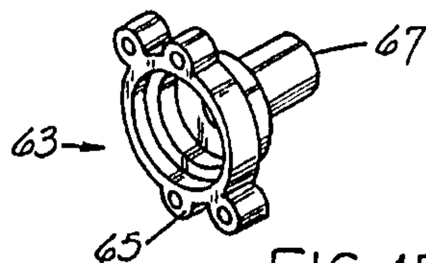

FIG. 15

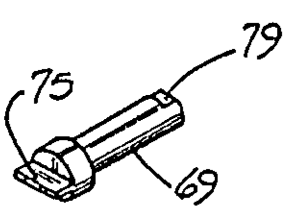

FIG. 16

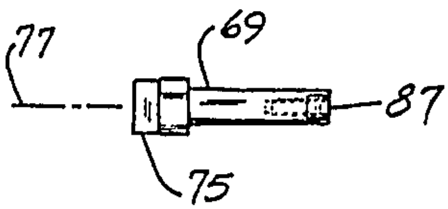

FIG. 17

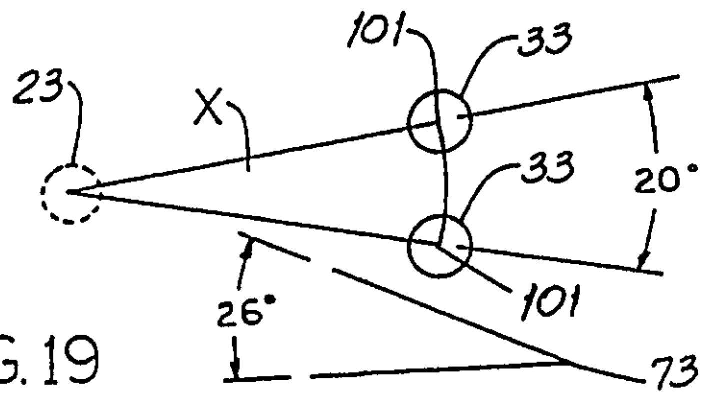

FIG. 19

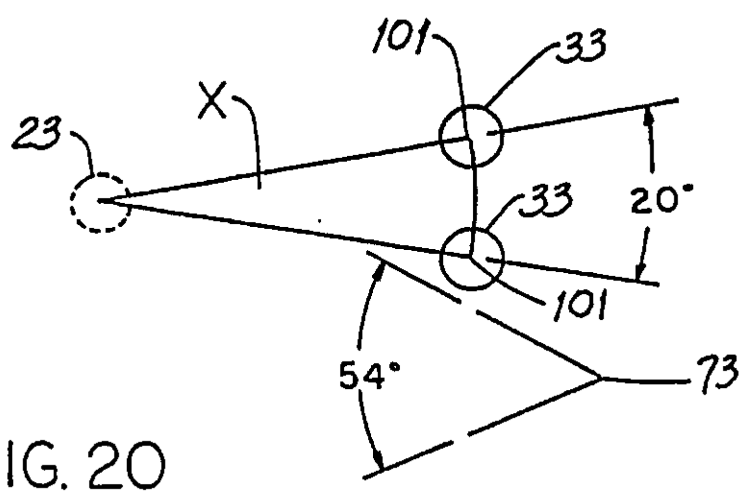

FIG. 20

VEHICULAR ACCELERATOR PEDAL APPARATUS

FIELD OF THE INVENTION

This invention relates generally to internal combustion engines and, more particularly, to such vehicular-mounted engines having an electrical device between the accelerator pedal and the engine speed regulator.

BACKGROUND OF THE INVENTION

Almost from the advent of the first motor vehicle powered by an internal combustion engine, engine speed control has been effected by an accelerator pedal mechanically coupled through the vehicle fire wall to an engine "speed regulator" such as a carburetor. When no pressure was applied to the pedal, the engine ran at some preset idle speed. And when vehicle-accelerating pressure was applied to the pedal, the pedal/carburetor linkage opened passages in the carburetor to admit more fuel to the engine. The linkage was "custom-configured" for the particular vehicle, engine and carburetor.

Much more recently, engine and vehicle manufacturers have turned to electrical and electronic engine speed control systems which sense engine temperature, engine load and the like and automatically control pump-fed fuel injectors to cause the proper amount of fuel to be admitted to the engine. Such systems are vastly more flexible in the way they can be installed in the vehicle and applied to the engine.

As but one example of improved flexibility in application, it is no longer required to extend a mechanical linkage through the vehicle firewall and provide appropriate sealing devices to prevent air leakage into the passenger compartment. Rather, electrical wires can be extended from the accelerator pedal mechanism to the electronic speed control on the engine.

A typical electrical engine throttle control system uses an electrical sensor, the output signal of which is a function of the position of the accelerator pedal. That is, the sensor "senses" pedal position between idle speed and maximum engine speed and the resulting signal is used by the electronic engine speed control system for engine speed regulation. A common sensor is embodied as a potentiometer or "pot" having a rotating stem. As the accelerator pedal is depressed and released, the stem rotates and an appropriate output signal results.

Examples of arrangements having an accelerator pedal and a sensor coupled thereto are disclosed in U.S. Pat. Nos. 4,958,607 (Lundberg); 4,976,166 (Davis et al.); 5,133,225 (Lundberg et al.); 5,237,891 (Neubauer et al.); 5,241,936 (Byler et al.) and 5,321,980 (Hering et al.). U.S. Pat. No. 5,133,321 (Hering et al.) discloses a resistive-type throttle control and idle-validation sensor combined into a single component.

While earlier arrangements have been generally satisfactory for the intended use, they are not without disadvantages. A notable disadvantage is that the pedal assembly hardware must be configured to accommodate a particular sensor made by a particular manufacturer. For example, the combined control and validation sensor disclosed in the above-noted Hering et al. patent is to be used with Cummins CELECT™ electronic fuel control system. The patent goes on to explain that the sensor may be "adapted" to operate with a variety of control systems and control devices.

Yet another apparent disadvantage is based upon the understanding that the arrangement of the Byler et al. patent uses a single sensor which may be adapted to any one of

several different engines and engine control systems. But engine and vehicle builders may wish to use their own sensor or one specified by them rather than one supplied by the manufacturer of the pedal hardware.

It is most preferable that an electronic accelerator pedal assembly be mounted on the front wall, often referred to as the fire wall, of the passenger compartment. The arrangements shown in the above-noted Byler et al. and Lundberg patents mount in that fashion. But those shown in the above-noted Davis et al. and Lundberg et al. patents mount adjacent to the floor where they are more susceptible to damage by water, dirt, foot-borne road salt and the like.

Yet another disadvantage of some prior art arrangements is that the accelerator pedal is biased to the engine idle position by a single spring. The apparatus shown in the above-noted Hering et al. patent is a example. But if the single spring fails, the pedal may move to a position representing some engine speed above idle, not a desirable condition.

The arrangement shown in the above-noted Byler et al. patent has pedal-biasing springs which are coiled flat ribbons and which are confined in a drum-like enclosure. If they become wet, such springs dry less easily than exposed springs and are not easily replaced. And, seemingly, manufacturing tooling for such arrangement may be more costly than is necessary in view of the invention.

An improved vehicular accelerator pedal apparatus which addresses disadvantages of prior art arrangements would be an important technical advance.

OBJECTS OF THE INVENTION

It is an object of the invention to provide an improved vehicular accelerator pedal apparatus which overcomes some of the problems and shortcomings of the prior art.

Another object of the invention is to provide such an accelerator pedal apparatus which may be easily configured to accommodate a variety of electrical sensors without modifying such sensors.

Another object of the invention is to provide such an accelerator pedal apparatus which mounts on a vehicle fire wall.

Another object of the invention is to provide such an accelerator pedal apparatus which readily accommodates any one of several sensors preferred by engine and vehicle builders.

Yet another object of the invention is to provide such an accelerator pedal apparatus which is of open construction and, therefore, easy to inspect and repair.

Another object of the invention is to provide such an accelerator pedal apparatus which involves reduced tooling expenditures for manufacture.

Still another object of the invention is to provide such an accelerator pedal apparatus which has redundant springs biasing the pedal to an engine-idle position. How these and other objects are accomplished will become apparent from the following descriptions and from the drawings.

SUMMARY OF THE INVENTION

The invention involves a vehicular accelerator pedal apparatus of the type which provides an electrical signal which represents the position of the pedal between idle speed and some maximum speed. The apparatus is used with electronic engine controls for controlling engine speed.

The apparatus has (a) a pedal position sensor, e.g., a potentiometer or "pot", mounted with respect to a bracket.

The pot has a stem rotatable about an axis of rotation. An actuator bar extends from the pedal toward the bracket.

In the improvement, the actuator bar is connected to a drive shaft which is pivot-mounted with respect to the bracket. A novel actuator linkage is coupled to and pivoted by the drive shaft and extends between the drive shaft and the sensor stem. In a specific embodiment, the linkage includes a connector driven by the drive shaft and a first link pin-coupled to the connector for pivoting about a first link axis. A second link is pivot-coupled to the first link and such second link drives a torque pin which imparts rotary motion to the pot stem when the pedal is moved and the linkage is pivoted by pedal movement. In a specific embodiment, the second link rotates with respect to the stem axis and in unison with the stem.

The first and second links each have spaced-apart distal and proximal ends and the following aspect of the invention is described in the order in which force "flows," i.e., is transmitted from the drive shaft to the pot stem. The actuator bar is rigidly attached to the drive shaft which, in turn, is coupled in driving engagement with a linkage connector. The proximal end of the first link is pivot-coupled to the connector and the distal end of such link is pivot-coupled to the distal end of the second link. The proximal end of the second link is coupled to the stem for stem rotation.

In another aspect of the invention, the new apparatus is configured to drive a sensor of a particular type, i.e., one in which the sensor stem includes a slot. The apparatus includes a sensor mounting device which is fixed to the bracket and has a face on which the sensor is mounted. The device has a tube extending toward the second link.

In addition to the connector and first and second links mentioned above, the actuator linkage includes a torque pin in the tube and extending between the stem and the second link. The torque pin has a driven end torque-coupled to the second link and has a sensor driving end coupled to the sensor stem. In a specific embodiment, the sensor driving end has a tongue which engages a slot in the stem. (The torque pin is so named because torque is applied to such pin by the second link and, in turn, the pin applies torque to the pot stem.)

It is desirable to have some sort of mechanical "stop" or "stops" which limit travel of the accelerator pedal and of apparatus components between an idle position and a maximum engine speed position. Accordingly, in a highly preferred embodiment, the apparatus mounting bracket includes an aperture having first and second boundary edges. A pin extends through the connector, through the first link and into the aperture and contacts the first boundary edge when the pedal is in the idle position. Such pin contacts the second boundary edge when the pedal is in the maximum-speed position.

As in a vehicle having a mechanical linkage to a carburetor, it is also desirable in the new apparatus to have the accelerator pedal biased to the idle position when such pedal is not in use. For that purpose, a preferred embodiment includes a biasing spring extending between the aforedescribed pin and a spring anchor point. Most preferably, the apparatus includes plural, i.e., redundant, biasing springs extending between the pin and the anchor point.

It will be recalled from the foregoing that the actuator bar is connected to a drive shaft which is pivot-mounted with respect to the bracket. In another inventive aspect of the new vehicular accelerator pedal apparatus, the drive shaft rotates with respect to a shaft axis and such axis is spaced from and parallel to the stem axis of rotation. And when the actuator bar and the drive shaft move from the idle position to the maximum speed position, the drive shaft rotates in a first direction and the stem rotates in a second direction opposite that of the first direction.

The foregoing description mentions a drive shaft connected to the pedal actuator bar and also mentions a pin which pivot-couples the connector and the first link to one another. The pin has a long axis and when the accelerator pedal is depressed and the actuator bar moved from the idle position to the maximum speed position, the drive shaft rotates through a shaft arc of X degrees. And when the actuator bar moves from the idle position to the maximum speed position, the pin long axis moves and defines a pin arc of X degrees. (The value of X depends upon the configuration of a particular apparatus and is likely to be in the range of from 5° to 35°–40° or so. In a specific apparatus, X is preferably in the range of from 15° to 25° and, most preferably, is 20°.)

Other details of the new vehicular accelerator pedal apparatus are set forth in the following detailed descriptions and in the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the new vehicular accelerator pedal apparatus.

FIG. 2 is another perspective view of the apparatus of FIG. 1.

FIG. 3 is a side elevation view of the apparatus of FIG. 1 taken along the viewing axis VA3 thereof. Surfaces of parts are shown in dashed outline.

FIG. 4 is a side elevation view of the apparatus of FIG. 1 taken along the viewing axis VA4 thereof. Surfaces of parts are shown in dashed outline.

FIG. 5 is a top plan view of the apparatus of FIG. 1 taken along the viewing axis VA5 of FIG. 4.

FIG. 6A is an exploded perspective view of most of the parts of the apparatus of FIG. 1.

FIG. 6B is a perspective view of the apparatus Connector shown in FIG. 6A.

FIG. 7 is a perspective view of the actuator bar and integral drive shaft of the apparatus.

FIG. 8 is a side elevation view of the pedal biasing spring of the apparatus.

FIG. 9 is an end elevation view of the spring of FIG. 8 taken along the viewing axis VA9 thereof.

FIG. 10 is a side elevation view of the connector of the apparatus showing in solid outline its position when the accelerator pedal is at the idle position and showing in dashed outline its position when the accelerator pedal is at a high-engine-speed position.

FIG. 11 is a perspective view of the connector pin of the apparatus.

FIG. 12 is a perspective view of the first link of the apparatus.

FIG. 13 is a perspective view of the bracket of the apparatus.

FIG. 14 is a side elevation view taken along the viewing axis VA14 of FIG. 13 and showing a portion of the bracket, also showing in solid outline the position of the pin of FIG. 11 when accelerator pedal is at the idle position and also showing in dashed outline the position of such pin when the accelerator pedal is at a high-engine-speed position.

FIG. 15 is a perspective view of the sensor mouting device of the apparatus.

FIG. 16 is a perspective view of the torque pin of the apparatus.

FIG. 17 is a side elevation view of the torque pin of the apparatus. Surfaces are shown in dashed outline.

FIG. 18 is an elevation view of the second link of the apparatus.

FIG. 19 is a representation of drive shaft and pin axis movement and the resulting angular movement of the sensor stem when a second link of a particular length is used in the apparatus.

FIG. 20 is a representation of drive shaft and pin axis movement and the resulting greater angular movement of the sensor stem when a longer second link is used in the apparatus.

DETAILED DESCRIPTIONS OF PREFERRED EMBODIMENTS

Referring to FIGS. 1 through 7, the new vehicular accelerator pedal apparatus 10 will be described starting with the speed-controlling "input" device, i.e., the accelerator pedal 11, and ending with a description of how any one of different sensors, a signal output device, are readily used as part of such apparatus 10. The apparatus 10 includes a foot pedal 11, the mounting bracket of which is pin-attached to a rigid actuator bar 13. For easy contact by a driver's foot, the pedal 11 is biased by a wire spring 15 (shown in FIGS. 4, 8 and 9) to a clockwise position (as viewed in FIG. 4) with respect to the bar 13.

A frame or bracket 17 is provided for mounting the components described below and such bracket 17 is attached to the vehicle fire wall using bolts or the like extending through the holes 19. The actuator bar 13 is bent at about a 90° angle at the location 21 to form a drive shaft 23 which is pivot-mounted with respect to the bracket 17. That is, the shaft 23 is journalled in bearings retained in the bracket 17.

As shown in FIGS. 2, 6A, 6B and 7, the shaft 23 (which is otherwise cylindrical) has a flat surface 25 formed thereon and the resulting D-shaped end 26 conforms in size and shape to a D-shaped drive hole 27 in the U-shaped connector 29 shown in FIGS. 6A, 6B and 10. The end 26, 23 is in the hole 27 and when the pedal 11 is depressed to rotate the shaft 26, 23 counterclockwise (as seen in FIG. 3—or clockwise as seen in FIG. 4) about the shaft axis 31, the connector 29 pivots in the same direction about the same axis 31.

Referring next to FIGS. 5, 6A, 6B, 11 and 12, a connector pin 33 extends through both lugs 35 of the connector 29 and through an aperture 37 in the proximal end 39 of a first link 41 positioned between the lugs 35. The pin 33 is held in position in the connector 29 by the pin shoulder 43 on one side of a lug 35 and by a retaining ring (not shown) on the other.

As shown in FIGS. 6A, 6B and 11, the pin 33 has three spaced-apart circumferential grooves 45, each receiving one hook end of a respective biasing spring 47 in tension. The other hook end of each spring 47 is attached to a spring anchor point embodied as an anchor bar 49 extending through the spaced legs 51 of the bracket 17. The pedal 11, actuator bar 13 and drive shaft 23 (as well as other components coupled directly or indirectly to the shaft 23) are biased to an engine idle position (see FIGS. 2 and 3) by the springs 47 which are redundant as to one another.

Referring particularly to FIGS. 2, 6A, 6B, 13 and 14, the bracket 17 includes a generally-elliptical aperture 53 having first and second boundary edges 55 and 57, respectively. The pin 33 is of sufficient length to extend into such aperture 53 and when the pedal 11 is in the idle position, the pin 33 contacts the first boundary edge 55 as shown in solid line in FIG. 14. And when the pedal 11 is in a maximum-speed position, the pin 33 contacts the second boundary edge 57 as shown in dashed outline in FIG. 14. From the foregoing, it is apparent that the pin 33 and the edges 55, 57 coact to limit travel of the pedal 11 between the idle position and the maximum speed position.

Before describing how the connector 29 is link-coupled to the electrical sensor 59, it will be helpful to have an understanding of how the sensor 59 is mounted and how its rotary stem 61 is configured. Referring next to FIGS. 2, 5, 6A, 6B, 15, 16 and 17, the apparatus 10 includes a sensor mounting device 63. The device 63 has a ring-like face 65 against which the sensor 59 is mounted and both the device 63 and the sensor 59 are secured to the bracket 17 by bolts or the like. The device 63 has a hollow, cylindrical tube 67 which extends away from the sensor 59 and such tube receives a torque pin 69, the function of which is explained below.

The sensor stem 61 has a slot 71 formed in it and located to be coincident with the stem axis of rotation 73. One end of the torque pin 69 includes a flat tongue 75 coincident with the pin long axis 77 and when the apparatus 10 is fully assembled, the tongue 75 is in the slot 71. Thus, rotation of the pin 69 rotates the stem 61. The other end of the torque pin 69 has a flat surface 79 formed on it and the resulting D-shaped end conforms in size and shape to a D-shaped drive opening 81 in the proximal end 83 of the second link 85 shown in FIGS. 1, 3, 6A, 6B and 18.

The end and the opening are retained in engagement with one another by a screw 87 threaded into a tapped hole in the pin 69. When the link 85 is pivoted about the stem axis 73, the stem 61 pivots in the same direction about the same axis 73 and through the same arc. As shown in FIGS. 1, 3 and 12, the distal end 91 of the first link 41 is pivot-coupled by a pivot pin 93 to the distal end 95 of the second link 85.

Considering the foregoing, in operation, the apparatus 10 is assumed to be at the engine idle position shown in FIGS. 1, 3 and 4. In such position, the biasing springs 47 urge the connector 29 and links 41, 85, to their respective positions. Absent spring-overpowering force applied to the pedal 11, such connector 29 and links 41, 85 are retained in such positions by the pin 33 bearing against the first boundary edge 55.

Considering FIGS. 3 and 10, when the pedal 11 is depressed to accelerate the vehicle engine, the actuator bar 13 moves in the direction of the arrow 97. The drive shaft 23 and connector 29 rotate in a first direction, e.g., counterclockwise, and the first link 41, being pivotably attached to the connector 29 by the pin 33, moves generally upwardly in the direction of the arrow 99. Movement of the link 41 causes the second link 85 (and the torque pin 69 and sensor stem 61 coupled to such link 85) to rotate in a second direction, e.g., clockwise, in the view of FIG. 3. Thus, the electrical output of the sensor 59 changes.

The pin 33 has a longitudinal axis 101 and from FIGS. 3, 10, 19 and 20, it will be appreciated that when the accelerator pedal 11 is depressed and the actuator bar 13 moved from the idle position to the maximum speed position, the drive shaft 23 rotates through a shaft arc of X degrees. In a very specific apparatus, X is 20°. As the drive shaft 23 rotates, the pin long axis 101 moves translationally and defines a pin arc of X degrees.

It has long been known that while movement of an accelerator pedal 11 and bar 13 is limited to, say, 20° or so,

commonly-used sensors 59 have a stem 61 which must be rotated through a significantly greater angle in order to provide a full range of engine-speed-controlling output signals. And the maximum stem rotation angle differs from sensor to sensor. For example, the sensor stem rotation angle may vary from about 55° to about 100° or so, depending upon the particular make and model of sensor in question.

An advantage of the new apparatus 10 is that it is very easily configured to accommodate any one of the different sensors now in common use. Considering FIG. 10 and the representation of FIG. 19 and using a second link 85 of a particular length, rotation of the drive shaft 23 and connector 29 through an arc of 20° (which causes movement of the pin axis 101 through a pin arc of 20°) causes an exemplary rotation of 26° of the torque pin 69 and the stem 61 about axis 73. If a longer second link 85 is used, FIGS. 10 and 20 represent that rotation of the drive shaft 23 and connector 29 through an arc of 20° causes an exemplary rotation of 54° of the torque pin 69 and the stem 61 about axis 73. The point is that the new apparatus 10 may be configured to accommodate a variety of sensors (i.e., sensors having stems 61 requiring differing arcs of rotation) by appropriately changing the length of the link 85.

The terms "mounted for rotation," "rotary movement," "axis of rotation" and the like should not be construed to imply that "rotation" and "rotary" mean moving through an arc of at least 360°. Rather, such terms mean that the structure is capable of some rotary movement. As used herein, the phrase "torque-coupled" means that the components which are so coupled, e.g., the torque pin 69 and the second link 85, are capable of transmitting force or torque from one to the other.

While the principles of the invention have been shown and described in connection with a few preferred embodiments, it is to be understood clearly that such embodiments are by way of example and are not limiting.

What is claimed:

1. In a vehicular accelerator pedal apparatus including (a) a pedal position sensor mounted with respect to a bracket and having a stem rotatable about an axis of rotation, (b) an accelerator pedal, and (c) an actuator bar extending from the pedal toward the bracket, the improvement wherein:

the actuator bar is connected to a drive shaft pivot-mounted with respect to the bracket;

an actuator linkage is coupled to and pivoted by the drive shaft;

the linkage extends between the drive shaft and the sensor stem;

the linkage includes a connector coupled to the drive shaft for coincident movement therewith; and

the linkage also includes rigid first and second links coupled between the connector and the stem and imparting rotary motion to the stem when the linkage is pivoted by movement of the pedal;

the second link has a proximal end coupled to the stem and has a distal end spaced from the proximal end of the second link;

the first link is pivot-coupled to the distal end of the second link.

the connector extends between the drive shaft and the first link;

the first link has a proximal end and a distal end;

the proximal end of the first link is pivot-coupled to the connector; and

the distal end of the first link is pivot-coupled to the distal end of the second link.

2. The apparatus of claim 1 wherein:

the accelerator pedal moves between an idle position and a maximum speed position;

the bracket includes an aperture therethrough and having first and second boundary edges;

a pin extends through the first link and through the aperture; and

when the pedal is in the idle position, the pin contacts the first boundary edge and is spaced from the second boundary edge.

3. The apparatus of claim 2 wherein, when the pedal is in the maximum-speed position, the pin contacts the second boundary edge and is spaced from the first boundary edge.

4. The apparatus of claim 2 wherein the bracket includes spaced legs having an anchor bar extending therethrough and the apparatus includes a biasing spring extending between the pin and the anchor bar, thereby biasing the pedal to the idle position.

5. In a vehicular accelerator pedal apparatus including (a) a pedal position sensor mounted with respect to a bracket and having a stem mounted for rotation about an axis of rotation, (b) an accelerator pedal, and (c) an actuator bar attached to the pedal and extending toward the bracket, the improvement wherein:

the actuator bar is connected to a drive shaft angularly attached to the actuator bar and pivot-mounted with respect to the bracket;

the drive shaft rotates with respect to a shaft axis;

an actuator linkage is coupled between the drive shaft and the stem and includes a connector driven by the drive shaft for pivoting movement about the shaft axis;

the shaft axis is spaced from and parallel to the stem axis of rotation and

when the connector pivots in a first direction about the shaft axis, the stem rotates in a second direction about the stem axis.

6. The apparatus of claim 5 wherein the actuator linkage includes:

a first link which pivots about a first link axis; and

a second link which is pivot-coupled to the first link and rotates in unison with the stem.

7. The apparatus of claim 5 wherein:

the actuator bar is mounted for movement between an idle position and a maximum speed position;

the actuator linkage includes a pin pivot-coupling the connector and a first link to one another;

the pin has a longitudinal axis;

and wherein, when the actuator bar is moved from the idle position to the maximum speed position:

the drive shaft rotates through a shaft arc of X degrees; and

the pin moves translationally and the pin longitudinal axis defines a pin arc of X degrees.

8. The apparatus of claim 7 includes a biasing spring extending between the pin and a spring anchor bar spaced from the pin and from the sensor stem, thereby biasing the actuator bar to the idle position.

9. The apparatus of claim 7 wherein:

the apparatus includes a sensor mounting device fixed to the bracket and having the sensor mounted thereon;

the actuator linkage includes a second link pivot-coupled to the first link;

the actuator linkage includes a torque pin extending between the sensor stem and the second link; and

the torque pin has a driven end torque-coupled to the second link and has a sensor driving end coupled to the stem.

10. In a vehicular accelerator pedal apparatus including (a) a pedal position sensor mounted with respect to a bracket and having a stem mounted for rotation about an axis of rotation, (b) an accelerator pedal, and (c) an actuator bar attached to the pedal and extending toward the bracket, the improvement wherein:

the actuator bar is connected to a drive shaft pivot-mounted with respect to the bracket;

the drive shaft rotates with respect to a shaft axis;

an actuator linkage is coupled between the drive shaft and the stem;

the shaft axis is spaced from and parallel to the stem axis of rotation;

the actuator bar is mounted for movement between an idle position and a maximum speed position;

and wherein, when the actuator bar is moved from the idle position to the maximum speed position:
the drive shaft rotates in a first direction; and
the stem rotates in a second direction.

11. The apparatus of claim 10 wherein the actuator linkage includes:

a first link which pivots about a first link axis; and

a second link which is pivot-coupled to the first link and rotates in unison with the stem.

12. In a vehicular accelerator pedal apparatus including (a) a pedal position sensor mounted with respect to a bracket and having a stem rotatable about an axis of rotation, (b) an accelerator pedal mounted for movement between an idle position and a maximum-speed position, and (c) an actuator bar extending from the pedal toward the bracket, the improvement wherein:

the actuator bar is connected to a drive shaft pivot-mounted with respect to the bracket;

an actuator linkage is coupled to and pivoted by the drive shaft;

the linkage extends between the drive shaft and the sensor stem;

the linkage includes a connector coupled to the drive shaft for coincident movement therewith;

the linkage also includes rigid first and second links coupled between the connector and the stem and imparting rotary motion to the stem when the linkage is pivoted by movement of the pedal;

the bracket includes an aperture therethrough and having first and second boundary edges;

a pin extends through the first link and through the aperture;

the pin contacts the first boundary edge when the pedal is in the idle position;

the bracket includes spaced legs having an anchor bar extending therethrough; and

the apparatus includes a biasing spring extending between the pin and the anchor bar, thereby biasing the pedal to the idle position.

* * * * *

Notice of References Cited	Application No. 09/643,422	Applicant(s) Steven J. Engelgau	
	Examiner Kwon, John	Group Art Unit 3747	Page 1 of 1

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
X	A	4,915,075	4/1990	Brown	123	399
x	B	4,938,304	7/1990	Yamaguchi et al.	123	399
x	C	4,958,607	9/1990	Lundberg	123	399
x	D	4,986,238	1/1991	Terazawa	123	399
x	E	5,215,057	6/1993	Sato et al.	123	399
x	F	5,233,882	8/1993	Byram et al.	123	399
x	G	5,460,061	10/1995	Redding et al.	74	560
x	H	5,632,183	5/1997	Rixon et al.	74	560
x	I	5,887,488	3/1999	Riggle	123	399
x	J	4,969,437	4/1990	Kolb	123	399
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
	N						
	O						
	P						
	Q						
	R						
	S						
	T						

NON-PATENT DOCUMENTS

*		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	U		
	V		
	W		
	X		

* A copy of this reference is not being furnished with this Office action.
(See Manual of Patent Examining Procedure, Section 707.05(a).)

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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

TELEFLEX INCORPORATED,

Plaintiff,

v.

KSR INTERNATIONAL CO.,

Defendant.

Case No. 02 74586

Hon. Lawrence P. Zatkoff

Magistrate Judge Pepe

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DECLARATION OF CLARK J. RADCLIFFE, PH.D.

I, Clark J. Radcliffe, being duly sworn, depose and state as follows:

1. I have personal knowledge of the facts stated in this Declaration, I am competent to testify to those facts, and I would testify to them if called upon to do so.

2. I am a Professor of Mechanical Engineering at Michigan State University and have served on that faculty since 1980.

3. I received my Bachelor of Science Degree in Mechanical Engineering from the University of California at Davis in 1969.

4. I received my Masters of Science Degree in Mechanical Engineering from the University of California at Davis in 1971.

5. I received my Doctor of Science Degree in Mechanical Engineering from the University of California at Berkeley in 1980.

6. I have reviewed the KSR Motion For Summary Judgment of Invalidity file July 7, 2003.

7. In my opinion, a person of ordinary skill in the art would be one with an undergraduate degree in mechanical engineering (or an equivalent amount of industry experience) who has familiarity with pedal control systems for vehicles.

8. I conducted my analysis by placing myself in the position of one of ordinary skill in the art.

9. I believe that the Engelgau '565 patent is valid and disagree with the KSR position that the Engelgau '565 patent is invalid. The arguments put forth in the motion are not sufficient to find the '565 patent invalid. I agree with the patent examiner's opinion and do not believe the claims to be obvious.

10. Contrary to KSR's position, the problem confronting the inventor of the '565 patent was not "... to provide an adjustable pedal assembly that could be installed in a vehicle whose engine utilized an electronic, rather than a cable-actuated, throttle control system." (pg. 21 of KSR Brief). The problem addressed by Engelgau '565 is to provide a less expensive, more quickly assembled, and smaller package adjustable pedal assembly with electronic control. ('565, col. 1, ll. 48-53)

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11. The prior art disclosed to the patent office in the '565 patent application included all of the technology disclosed in the Asano '782 patent. The Asano '782 patent provides no new information pertinent to the arguments put forth by KSR.

12. Both the prior art cited in '565 as well as the Asano '782 patent show adjustable pedal assemblies that "...can be expensive, time consuming to assemble, and require a significant amount of packaging space."

13. In contrast, the '565 patent claims a structure that addresses the problem faced by Engelgau and provides an "ADJUSTABLE PEDAL ASSEMBLY WITH ELECTRONIC THROTTLE CONTROL" that is less expensive, requires less time to assemble, and utilizes a smaller packaging space than the prior art.

14. It would not have been obvious to one of ordinary skill in the art to address the problem stated in the '565 patent through the combination of features claimed in the patent.

15. The electronic control in the '565 patent that responded to pivotal motion of the adjustable pedal at the support provided a simpler mounting position, that was both less expensive and easier to package than devices in the prior art. The location of the electronic control facilitating these advantages would not have been obvious to one of ordinary skill in the art.

16. Both the Asano '782 and the Rixon '593 prior art devices are complex mechanical linkage-based devices that are expensive to produce and assemble and difficult to package. It is exactly these difficulties with prior art designs that the Engelgau '565 patent resolves. The use of an adjustable pedal with a single pivot reflecting pedal position combined with an electronic control mounted between the support and the adjustment assembly at that pivot was a simple, elegant, and novel combination of features in the Engelgau '565 patent.

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17. The Rixon '593 prior art device was before the patent examiner. This device was an adjustable pedal assembly with an electronic throttle control, so the novelty of the Engelgau patent must lie elsewhere. The use of an electronic control in the '593 patent's adjustable pedal assembly is located away from the pedal assembly's support requiring more complex mounting — both mechanically and electrically. As discussed in the '565 patent's background, the complexity, cost, and packaging difficulty of this electronics mounting motivated the problem addressed by the '565 patent.

18. KSR's GMT-360 and GMT-800 adjustable pedal assemblies include the combination of features in Claim 4 of the Engelgau '565 patent. The apparent commercial success of pedals with this combination of features that validates the novelty of this simple, elegant, solution to the inventor's problem.

19. I reserve the right to amend or supplement my opinions as I review new or additional information and documents produced. I also reserve the right to respond to opinions expressed by technical and/or other experts. Finally, I reserve the right to amend or supplement my opinions if any of the terms of the claims of the patent are construed in a manner inconsistent with my construction of them.

Aug 9, 2003
Date

Clark J Radcliffe
Clark J. Radcliffe

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UNITED STATES DISTRICT COURT
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DECLARATION OF TIMOTHY L. ANDRESEN

I, Timothy L. Andresen, being duly sworn, depose and state as follows:

1. I have personal knowledge of the facts stated in this Affidavit, I am competent to testify to those facts, and I would testify to them if called upon to do so.

2. I received a B.S. Aeronautical Engineering degree from the University of Michigan in 1964 and a M.S. Mechanical Engineering degree from the University of Missouri in 1968.

3. I retired from Ford Motor Company in January 1999. During my employment at Ford from 1973 to 1999 I worked primarily with passenger car brake systems and the included components.

4. From 1964 to 1973 I worked as an engineer at McDonnel-Douglas Corp., St. Louis, Missouri (now part of Boeing Corp.) I specialized in aerodynamic heating and structural temperature analysis of various spacecraft.

5. Two patents for Adjustable Pedal Assemblies are Rixon, U.S. Patent No. 5,722,302 dated March 3, 1998 and Rixon, U.S. Patent No. 5,632,183 dated May 27, 1997. Neither of these patents includes an ETC. When Rixon patented an Electronic Adjustable Pedal Assembly with ETC, Rixon, U.S. Patent No. 5,819,593, dated October 13, 1998, he modified the housing (24) to accommodate the ETC as opposed to placing the ETC on the pedal mounting bracket. This supports my conclusion that placing the ETC on the mounting bracket would not have been obvious to someone familiar with adjustable pedals. I believe that consideration of patents for stationary foot pedals used with ETC — Byram, U.S. Patent No. 5,233,882; Riggle, U.S. Patent No. 5,887,488; Lundberg, U.S. Patent No. 4,958,607; Brown, U.S. Patent No. 4,915,075; Stewart, U.S. Patent No. 5,408,899; Byler, U.S. Patent No. 5,241,935; and White, U.S. Patent No. 5,385,068 — reinforces this conclusion.

6. Placing the ETC where it moves during pedal adjustment can be undesirable due to the potential for electrical connector wire fatigue failure and/or insulation abrasion.

7. I have review the Engelgau patent, U.S. Patent No. 6,237,565, and conclude that it solves the undesirable feature cited in No. 6 above by separating the pedal adjustment movement from the ETC. This is a critical feature and in my opinion this design would not have been obvious to someone familiar with the state of the art.

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8. I have read the KSR Motion for Summary Judgment of Invalidity. None of the references KSR uses to establish prior art show an ETC which does not move with the pedal during adjustment.

9. It is my opinion that the Engelgau patent, U.S. Patent No. 6,237,565 incorporates the ETC in a fashion that optimizes package space requirements, minimizes weight, and simplifies the overall design. I do not believe this design would have been obvious to someone familiar with the prior art.

10. I have considered the Asano patent and the electronic control reference cited by KSR in its brief. I do not believe that the combination of Asano with an electronic control would have solved the problem addressed by the Engelgau patent.

11. I have reviewed the patents that were cited to the examiner during consideration of the Engelgau patent application and agree with the examiner that the Engelgau design has features that were not obvious based on the prior art.

Timothy L. Andresen 8/8/03

Timothy L. Andresen

US006237565B1

(12) **United States Patent**
Engelgau

(10) Patent No.: **US 6,237,565 B1**
(45) Date of Patent: ***May 29, 2001**

(54) ADJUSTABLE PEDAL ASSEMBLY WITH ELECTRONIC THROTTLE CONTROL

(75) Inventor: Steven J. Engelgau, Royal Oak, MI (US)

(73) Assignee: Teleflex Incorporated, Plymouth Meeting, PA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: 09/643,422

(22) Filed: Aug. 22, 2000

Related U.S. Application Data

(63) Continuation of application No. 09/236,975, filed on Jan. 26, 1999, now Pat. No. 6,109,241.

(51) Int. Cl.[7] F02D 1/00
(52) U.S. Cl. 123/399; 74/560
(58) Field of Search 123/399; 74/560

(56) **References Cited**

U.S. PATENT DOCUMENTS

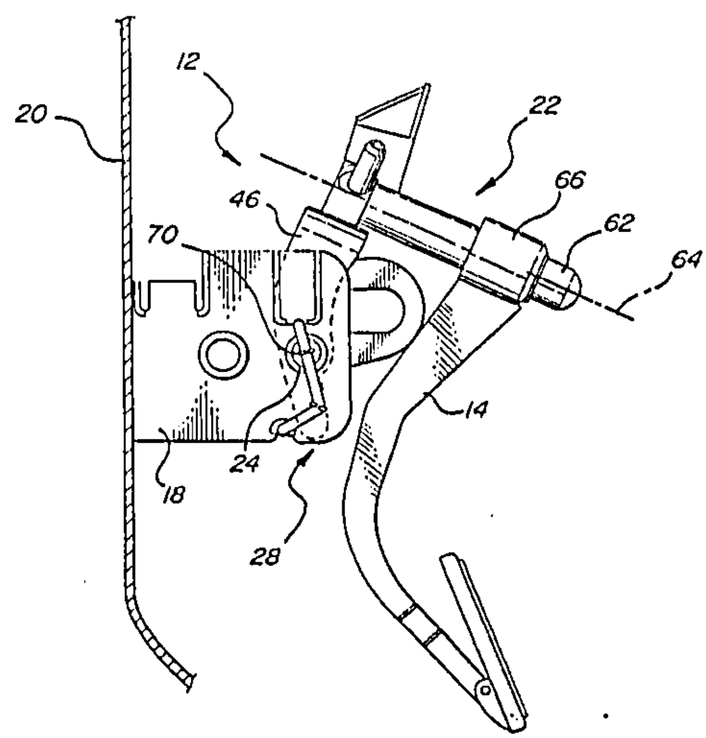
4,470,570 9/1984 Sakurai et al. 244/235
5,056,742 10/1991 Sakurai 244/235

Primary Examiner—John Kwon
(74) *Attorney, Agent, or Firm*—Howard & Howard

(57) **ABSTRACT**

A vehicle control pedal apparatus (12) includes a support (18) adapted to be mounted to a vehicle structure (20) and an adjustable pedal assembly (22) having a pedal arm (14) that is moveable in fore and aft directions with respect to the support (18). A pivot (24) pivotally supports the adjustable pedal assembly (22) with respect to the support (18) and defines a pivot axis (26). The control pedal apparatus (12) further includes an electronic throttle control (28) attached to the support (18) for controlling an engine throttle (30). The apparatus (12) is characterized by the electronic throttle control (28) being responsive to the pivot (24) for providing a signal (32) that corresponds to pedal arm position as the pedal arm (14) pivots about the pivot axis (26) between rest and applied positions. Thus, the control pedal apparatus (12) can adjust pedal arm position in fore and aft directions without having to move the electronic throttle control unit (28) along with the pedal arm (14). Additionally, the electronic throttle control (28) is responsive to the pivot (24) about which the adjustable pedal assembly (22) rotates.

4 Claims, 4 Drawing Sheets



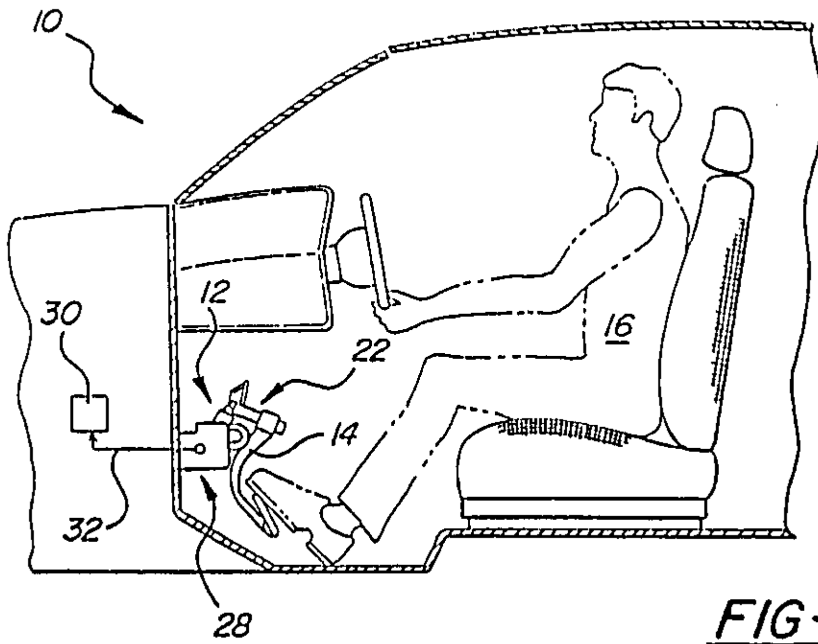


FIG - 1

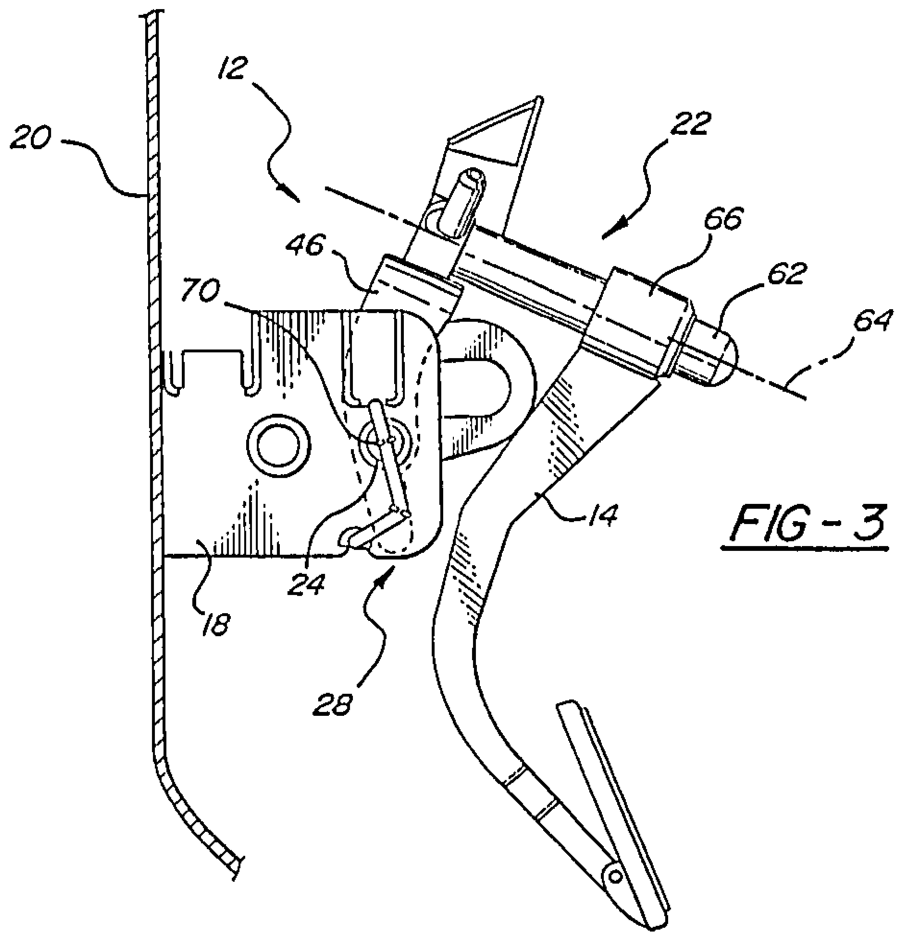
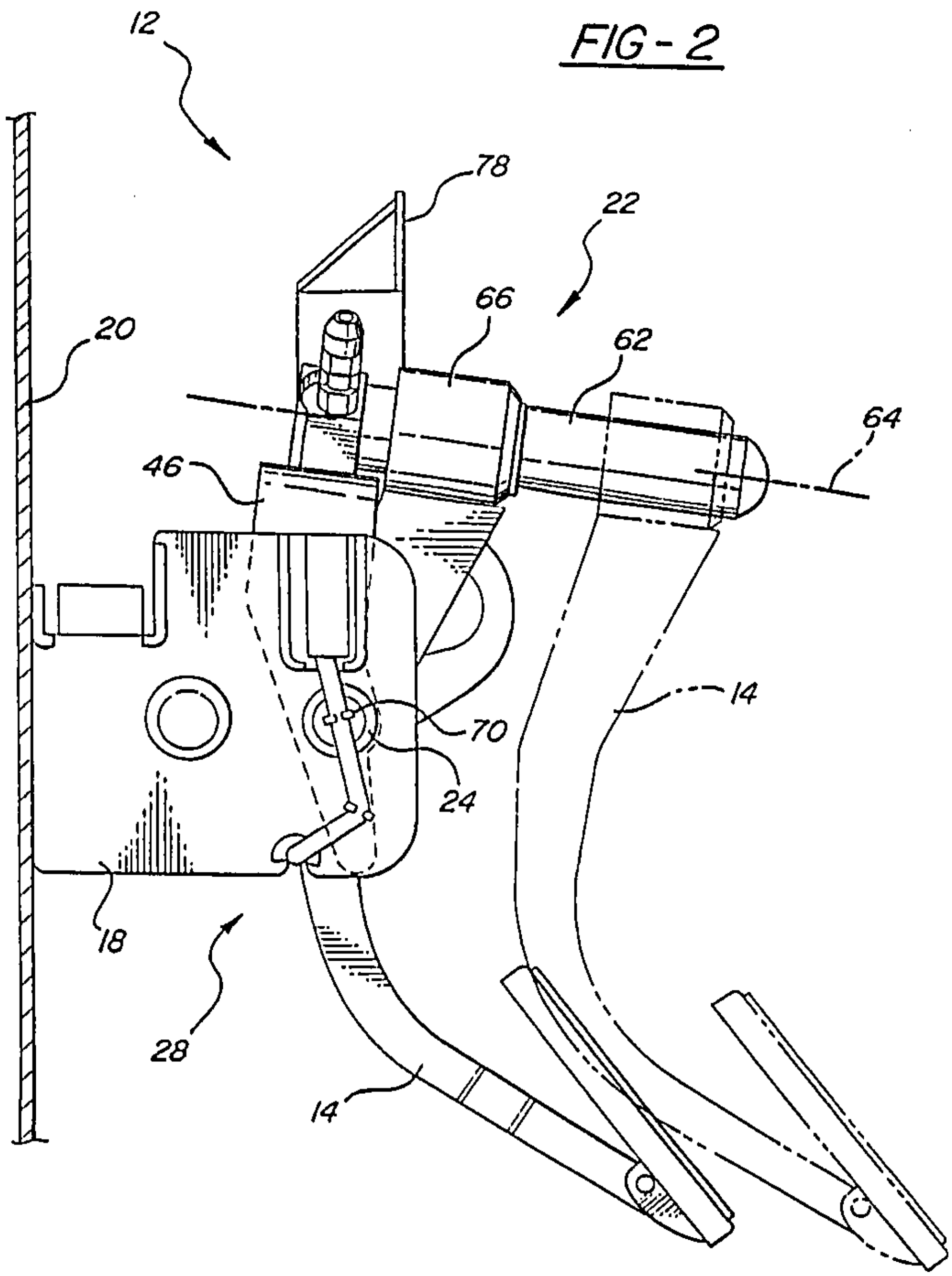


FIG - 3

FIG - 2



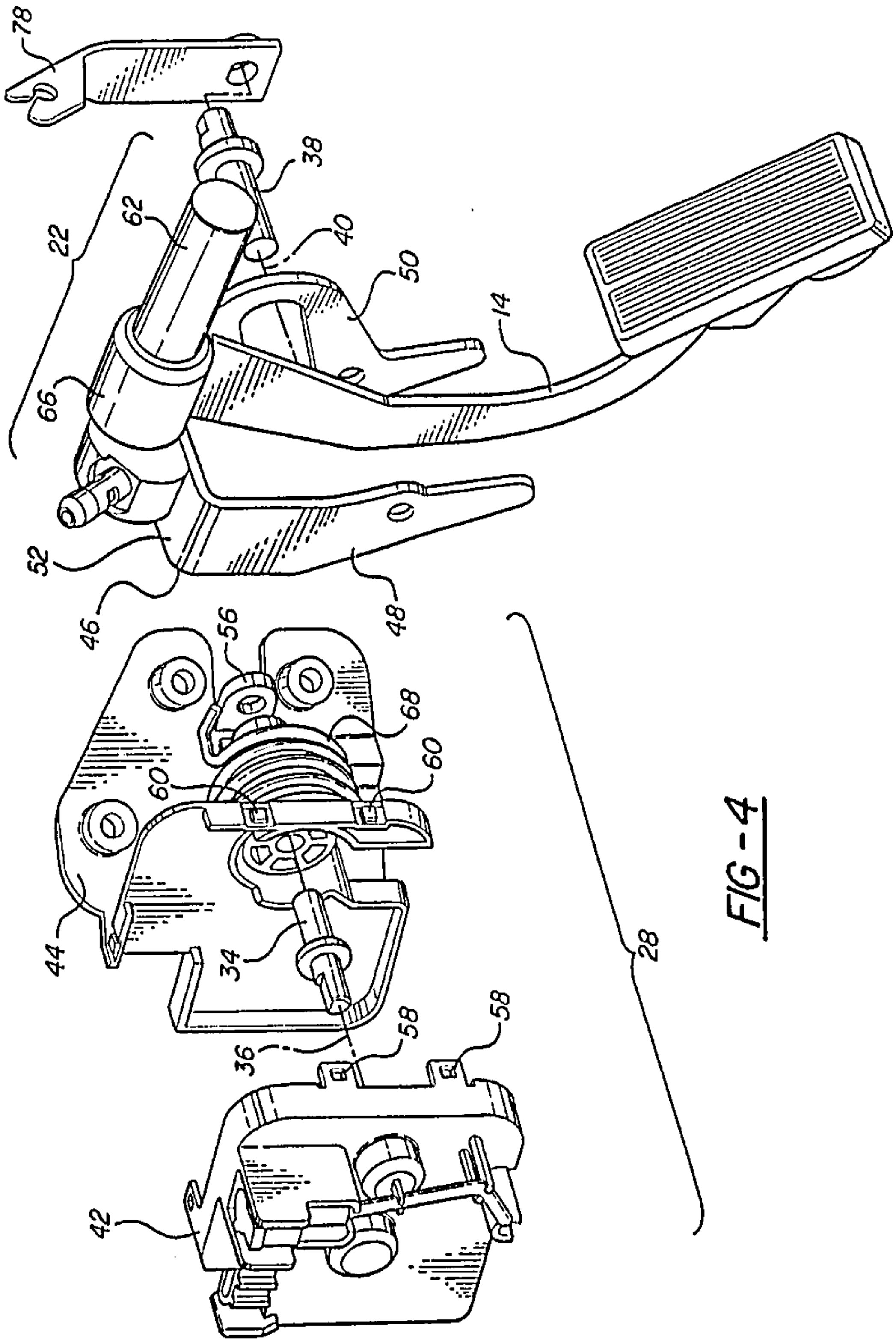


FIG-4

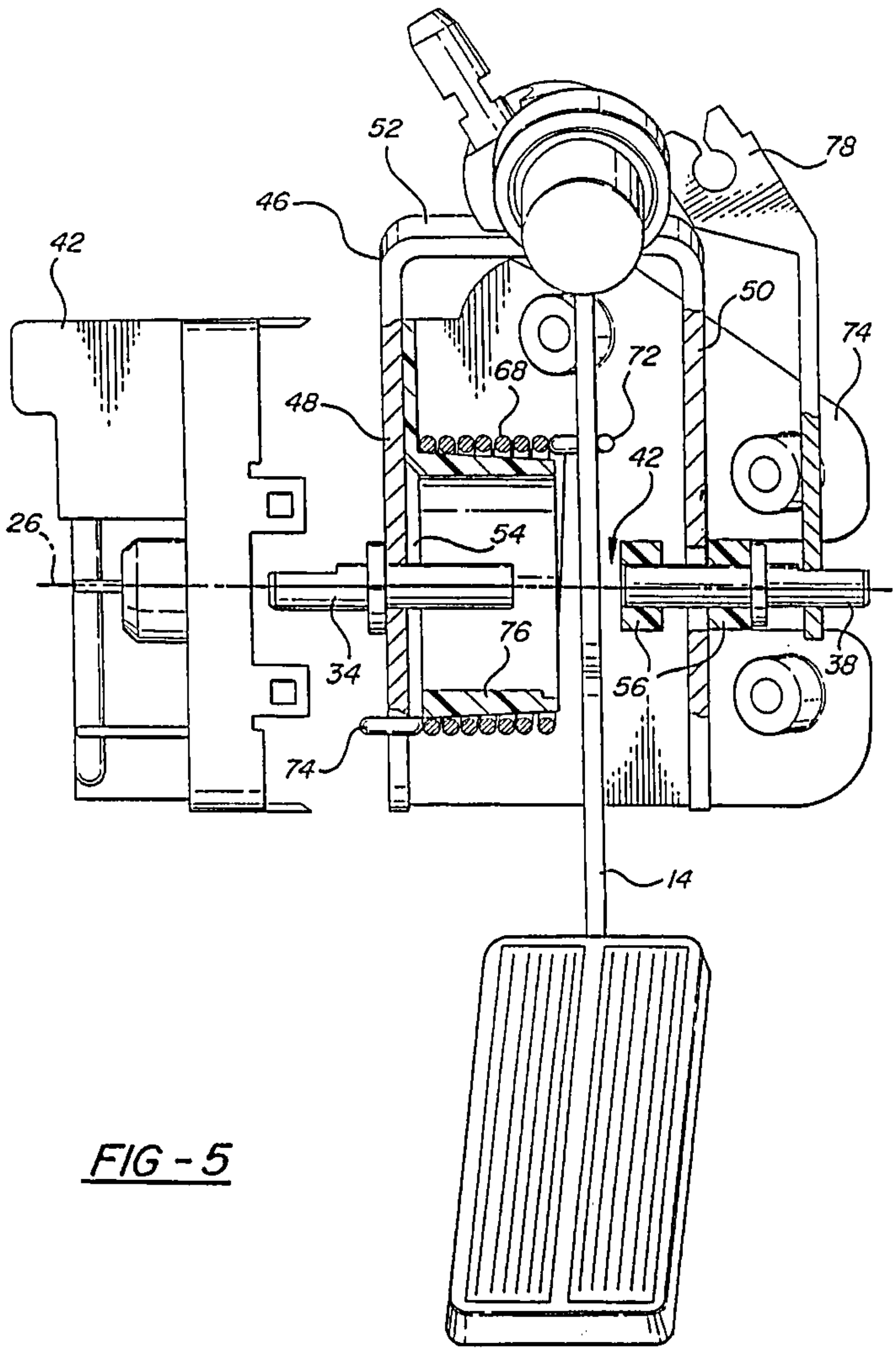


FIG - 5

ADJUSTABLE PEDAL ASSEMBLY WITH ELECTRONIC THROTTLE CONTROL

RELATED APPLICATION

This application is a continuation of application Ser. No. 09/236,975, filed Jan. 26, 1999, U.S. Pat. No. 6,109,241.

TECHNICALLY FIELD

The subject invention relates to vehicle control pedal assembly having an adjustment mechanism for moving a pedal arm in fore and aft directions and an electronic throttle control for controlling an engine throttle. Specifically, the pedal assembly includes a pivot about which the adjustment mechanism rotates when the pedal arm is actuated and which provides input to the electronic throttle control for providing a signal that corresponds to pedal arm position.

BACKGROUND OF THE INVENTION

Pedal assemblies are used in vehicles to control the movement of the vehicle. For example, a vehicle driver applies a force to an accelerator pedal to move the pedal from a rest position to an applied position. In the applied position, the accelerator pedal typically actuates an engine throttle, which controls the acceleration and speed of the vehicle. Often these pedal assemblies include an adjustment apparatus that allows the position of a pedal arm and/or a pedal pad to be moved with respect to the driver. This allows the pedal assembly to accommodate drivers of various heights. Thus, the adjustment apparatus allows the pedal assembly to be moved closer to the driver when the driver is short and allows the pedal assembly to be moved further away from the driver when the driver is tall. Examples, of adjustable pedal assemblies are shown in U.S. Pat. Nos. 5,460,061 and 5,632,183 all assigned to the assignee of the subject invention.

Additionally, adjustable pedal assemblies can include an electronic throttle control assembly for a drive-by-wire system. The electronic throttle control assembly is used to generate an electrical signal that corresponds to the position of the accelerator pedal. The electronic throttle control assembly replaces traditional mechanical linkages between the pedal arm and the engine throttle. One such adjustment apparatus used with an electronic throttle control is shown in U.S. Pat. No. 5,819,593 assigned to the assignee of the present invention.

When a vehicle control pedal assembly includes both an adjustment apparatus and an electronic throttle control, the pedal assembly can be complex with a great number of parts. These control pedal assemblies can be expensive, time consuming to assemble, and require a significant amount of packaging space.

SUMMARY OF THE INVENTION AND ADVANTAGES

A vehicle control pedal apparatus includes a support adapted to be mounted to a vehicle structure and an adjustable pedal assembly with a pedal arm that is moveable in fore and aft directions with respect to the support. A pivot pivotally supports the adjustable pedal assembly with respect to the support and defines a pivot axis. The control pedal apparatus further includes an electronic throttle control attached to the support for controlling an engine throttle. The apparatus is characterized by the electronic throttle control being responsive to the pivot for providing a signal corresponding to pedal arm position as the pedal arm pivots about the pivot axis between rest and applied positions. Accordingly, the subject invention provides a simplified vehicle control pedal assembly that is less expensive, and which uses fewer parts and is easier to package within the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a side view of a vehicle, partially in cross-section, including the subject pedal assembly,

FIG. 2 is a side view of the subject pedal assembly showing a pedal arm in fore and aft positions;

FIG. 3 is a side view of the subject pedal assembly in a pivoted position;

FIG. 4 is an exploded view of the pedal assembly shown in FIG. 3; and

FIG. 5 is a front view, partially in cross-section , of the pedal assembly shown in FIG. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a vehicle 10 with a control pedal apparatus 12 is shown in FIG. 1. The control pedal apparatus 12 includes a pedal arm 14 that can be adjusted in fore and aft directions with respect to the vehicle 10 by a driver 16. This adjustment capability allows the pedal arm 14 to be positioned to accommodate drivers 16 of various heights.

The vehicle control pedal apparatus 12 includes a support 18 adapted to be mounted to a vehicle structure 20 such as a firewall or dash member, for example. The support 18 can be a bracket, housing, or other structural support member known in the art. The support 18 can be a unitary member that is attached directly to the vehicle structure 20 or the support 18 can be comprised of a plurality of support members, one of which is attached to the vehicle structure 20.

As shown in FIGS. 2 and 3, the control pedal apparatus 12 further includes an adjustable pedal assembly 22 with a pedal arm 14 that is moveable in fore and aft directions with respect to the support 18. In FIG. 2, the pedal arm 14 is shown in the furthest adjustment position in the fore direction in solid lines and in the furthest adjustment position in the aft direction in dashed lines. The adjustable pedal assembly 22 preferably includes an electric motor (not shown) for controlling the movement of the pedal arm 14 in the fore and aft directions, as is well known in the art. The adjustable pedal assembly 22 can be any of various adjustable pedal assemblies known in the art. For example, the adjustable pedal assembly 22 could be similar to the adjustable pedal assembly in U.S. Pat. No. 5,632,183 assigned to the assignee of the present invention and incorporated herein by reference.

A pivot 24 pivotally supports the adjustable pedal assembly 22 with respect to the vehicle structure 20 and defines a pivot axis 26 (shown in FIG. 5). The pivot 24 is preferably comprised of a first pivot member 34 defining a first pivot member axis 36 and a second pivot member 38 defining a second pivot member axis 40. The first 36 and second 40 pivot member axes are collinear to define the pivot axis 26.

While two pivot members 34, 38 are preferred a single pivot could be used or additional pivot members could be used to provide additional pivotal support.

The first 34 and second 38 pivot members are longitudinally spaced apart from one another to define a clearance space 42 for the pedal arm 14 as the pedal arm 14 pivots about the pivot axis 26. Thus, when the pedal arm 14 is moved from a rest position to an applied position, as shown in FIG. 3, the pedal arm 14 can move between the first 34 and second 38 pivot members without coming into contact with the pivot members 34, 38. If only a single pivot member is used, the clearance space 42 between pivot members is not needed.

The control pedal apparatus 12 also includes an electronic throttle control mechanism 28 attached to the vehicle structure 20 for controlling an engine throttle 30 shown schematically in FIG. 1. The electronic throttle control 28 is responsive to the pivot 24 and provides a signal 32 that corresponds to pedal arm position as the pedal arm 14 pivots about the pivot axis 26 between rest and applied positions. Thus, the signal 32 will vary as the pedal arm 14 moves from the rest position to the applied position. The electronic throttle control mechanism 28 can be any of various electronic throttle control mechanisms known in the art, as the one described in U.S. Pat. No. 5,819,593 assigned to the assignee of the present invention and incorporated herein by reference.

The electronic throttle control 28 is preferably responsive to the first pivot member 34 to provide the signal 32 that corresponds to pedal arm position. The second pivot member 38 preferably provides pivotal balance for the pedal arm 14 as the pedal arm 14 pivots about the pivot axis 26. It should be understood however that the electronic throttle control 28 could also be mounted on the opposite side of the control pedal assembly 12 such that the second pivot member 38 provides input to product the signal 32 while the first pivot member 34 provides additional balance for the pedal arm 14 as it pivots.

The electronic throttle control mechanism 28 preferably includes a first housing portion 42 and a second housing portion 44, shown in FIG. 4. In the preferred embodiment the housing portions 42, 44 partially serve as the support 18 for the control pedal apparatus 12 and are fixed relative to the vehicle structure 20. The adjustable pedal assembly 22 is supported on a bracket 46 that is mounted to the housing portions 42, 44. The second housing portion 44 includes a first pivotal support 54 and a second pivotal support 56. The first pivotal support 54 receives the first pivot member 34 and the second pivotal support 56 receives the second pivot member 38. As discussed above, the first 34 and second 38 pivot members form the pivot 24 about which the pedal arm 14 pivots.

The bracket 46 includes a first leg 48 and a second leg 50 that extend downwardly from a central base member 52. While the bracket 46 is shown with two legs 48, 50, the bracket 46 could also be configured to have only a single leg or could have additional leg members. The bracket 46 need only provide partial support for the adjustable pedal assembly 22.

The bracket 46 is partially installed within the second housing member 44 such that the first pivotal support 54 is adjacent to the first leg 48 and the second pivotal support 56 is adjacent to the second leg 50. The first housing portion 42 is attached to the second housing portion near the first pivotal support 54 to enclose the electronic throttle control 28. The first housing portion 42 preferably includes tab receivers 58 for snap fit attachment to tabs 60 located on the second housing portion 44.

The bracket 46 pivots about the pivot axis 26 when a force is applied to the pedal arm 14 to move the pedal arm 14 from the rest to the applied position. The electronic throttle control 28 is fixed with respect to the vehicle structure 20 such that the pedal arm 14 moves in fore and aft directions with respect to the electronic throttle control 28 and with respect to the vehicle structure 20. Thus, the adjustable pedal assembly 22 pivots with respect to the vehicle structure 20 and moves the pedal arm 14 in fore and aft directions with respect to the vehicle structure 20, while the electronic throttle control 28 remains fixed with respect to the vehicle structure 20. In other words, the pedal arm 14 moves independently from the electronic throttle control 28. Additionally, the pedal arm 14 moves in fore and aft directions with respect to the pivot 24.

The adjustable pedal assembly 22 includes a guide rod 62 for supporting the pedal arm 14 and which defines a longitudinal axis 64. The pedal arm 14 moves in the fore and aft directions along the longitudinal axis 64. The longitudinal axis 64 is perpendicular to the pivot axis 26. Thus, the guide rod 62 is rotatable about the pivot axis 26 along with the bracket 46 when the pedal arm 14 pivots about the pivot axis 26.

The adjustable pedal assembly 22 further includes a bearing member 66 for slidably supporting the pedal arm 14 on the guide rod 62. The bearing member 66 is preferably a bushing, however, other bearing members well known in the art can be used. In the preferred embodiment, an electric motor is used to drive a screw drive mechanism housed within the guide rod 62, which causes the bearing member 66 and the pedal arm 14 to move along the guide rod 62.

The control pedal apparatus 12 also includes a resilient member 68, shown in FIG. 5, which reacts between the pedal arm 14 and the bracket 46 for providing resistance as the pedal arm 14 is moved from the rest position to the applied position. This resistance provides a "feel" 16 as the pedal arm 14 pivots that corresponds to the feel that a driver experiences in pedal assembly having a cable assembly as part of a mechanical link to the engine throttle 30. The resilient member 68 is preferably a coil spring with a spring center 70 that is concentric with the pivot 24. The spring 68 has a first spring end 72 engaging the pedal arm 14 and a second spring end 74 engaging the bracket 46. In addition to providing resistance as the pedal arm 14 is moved to the applied position, the spring 68 returns the pedal arm 14 to the rest position after a force applied to the pedal arm 14 has been removed.

The spring 68 is supported by a cylindrical portion 76 that extends inwardly from the second housing portion 44 of the electronic throttle control 28, toward the pedal arm 14. Thus, the cylindrical portion 76 is located between the pedal arm 14 and the first leg 48 of the bracket 46.

While the spring 68 is shown as a coil spring that is supported about pivot 24, other spring configurations known in the art could also be used. Also, the spring 68 could be located at a position other than about pivot 24. The main function of the spring 68 is to act upon the pedal arm 14 to provide a feel to the driver as the pedal arm 14 pivots.

A cable attachment member 78 can optionally be supported on one of the pivot members 34, 38 to support a cable assembly for attachment to the engine throttle 30. This configuration would be used in place of the electronic throttle control 28; i.e., the configuration is used with a pedal assembly having a mechanical link to the throttle.

The control pedal apparatus 12 of the subject invention provides both an adjustment apparatus 22 and an electronic throttle control 28 in an assembly that requires less packaging space and which requires fewer components than prior art control pedals. This reduces overall assembly time and reduces material costs. The control pedal apparatus 12 provides the additional benefits of having a single pivot (24) to pivotally support the pedal arm 14 in addition to providing input to the electronic throttle control 28. Thus, the control pedal apparatus 12 allows adjustment of the pedal arm 14 in fore and aft directions without having to move the electronic throttle control unit 28 along with the pedal arm 14, and the electronic throttle control 28 is responsive to the pivot 24 about which the adjustable pedal assembly 22 rotates.

The invention has been described in an illustrative manner, and it is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, wherein reference numerals are merely for convenience and are not to be in any way limiting, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An adjustable pedal assembly for a vehicle comprising:

a support (18) for mounting to a vehicle structure;

an adjustable pedal assembly (22) having a guide member (62) rotatably supported by said support (18) for pivotal movement about a pivot axis (26); and

a pedal arm (14) supported on said guide member (62) for rectilinear movement in fore and aft directions relative to said support (18), said guide member (62) and said pivot axis (26) between various adjusted positions;

an electronic control (28) supported on said support (18) and responsive to pivotal movement of said pedal arm (14) and said guide member (62) about said pivot axis (26),

said electronic control (28) being fixed relative to said support (18) such that said pedal arm (14) moves in fore and aft directions with respect to said electronic control (28), said electronic control (28) being responsive to pivotal movement of said guide member (62) about said pivot axis (26) for providing a signal (32) that corresponds to pedal arm (14) position as said pedal arm (14) pivots said guide member (62) about said pivot axis (26).

2. An assembly as set forth in claim 1 wherein said pedal arm (14) is in sliding engagement with said guide member (62) and extends from said guide member (62) to lower pad end.

3. An assembly as set forth in claim 2 including a drive for moving said pedal arm (14) along said guide member (62).

4. A vehicle control pedal apparatus (12) comprising:

a support (18) adapted to be mounted to a vehicle structure (20);

an adjustable pedal assembly (22) having a pedal arm (14) moveable in force and aft directions with respect to said support (18);

a pivot (24) for pivotally supporting said adjustable pedal assembly (22) with respect to said support (18) and defining a pivot axis (26); and

an electronic control (28) attached to said support (18) for controlling a vehicle system;

said apparatus (12) characterized by said electronic control (28) being responsive to said pivot (24) for providing a signal (32) that corresponds to pedal arm position as said pedal arm (14) pivots about said pivot axis (26) between rest and applied positions wherein the position of said pivot (24) remains constant while said pedal arm (14) moves in fore and aft directions with respect to said pivot (24).

* * * * *

United States Patent [19]

Asano et al.

[11] Patent Number: 5,010,782

[45] Date of Patent: Apr. 30, 1991

[54] POSITION ADJUSTABLE PEDAL ASSEMBLY

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[73] Assignee: Fuji Kiko Company, Ltd., Tokyo, Japan

[21] Appl. No.: 386,401

[22] Filed: Jul. 28, 1989

[30] Foreign Application Priority Data

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Jul. 28, 1988	[JP]	Japan	63-188775
Jul. 28, 1988	[JP]	Japan	63-188776
Jul. 28, 1988	[JP]	Japan	63-188777

[51] Int. Cl.^{5} G05G 1/14

[52] U.S. Cl. 74/512; 74/513; 74/560

[58] Field of Search 74/512, 513, 560, 522, 74/561, 562

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Primary Examiner—Vinh T. Luong
Attorney, Agent, or Firm—Ronald P. Kananen

[57] ABSTRACT

In a position adjustable pedal assembly for a vehicle, a pedal pad position is adjustable in a longitudinal direction of the vehicle. A lever is connected to a stationary bracket for a pivotal movement about a pivot axis and is formed with a linear track extending in the vehicular longitudinal direction. A pedal arm is provided with a pedal pad at its lower end and with a guide member at its upper end and is connected to the lever for the pivotal movement with the lever in response to a depression force applied to the pedal pad. An adjust lever is provided on the lever for a relative movement to the lever and is formed with an arc-shaped track. The relative movement of the adjust lever is caused when the guide member moves within the linear track and simultaneously within the arc-shaped track while the pedal pad position is adjusted. The adjust lever is provided with a connecting member which is movable within another arc-shaped track in response to the relative movement of the adjust lever. Accordingly, when the pedal pad position is adjusted to move the guide member, the relative movement of the adjust lever is caused to vary a position of the connecting member corresponding to a magnitude of the movement of the guide member, i.e., corresponding to the variation in a distance from the pivot axis to the pedal pad. The depression force is applied to a vehicle operation system through the connecting member.

12 Claims, 7 Drawing Sheets

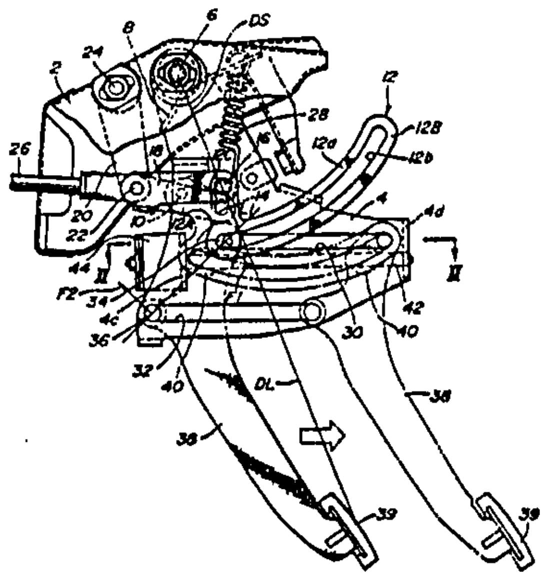
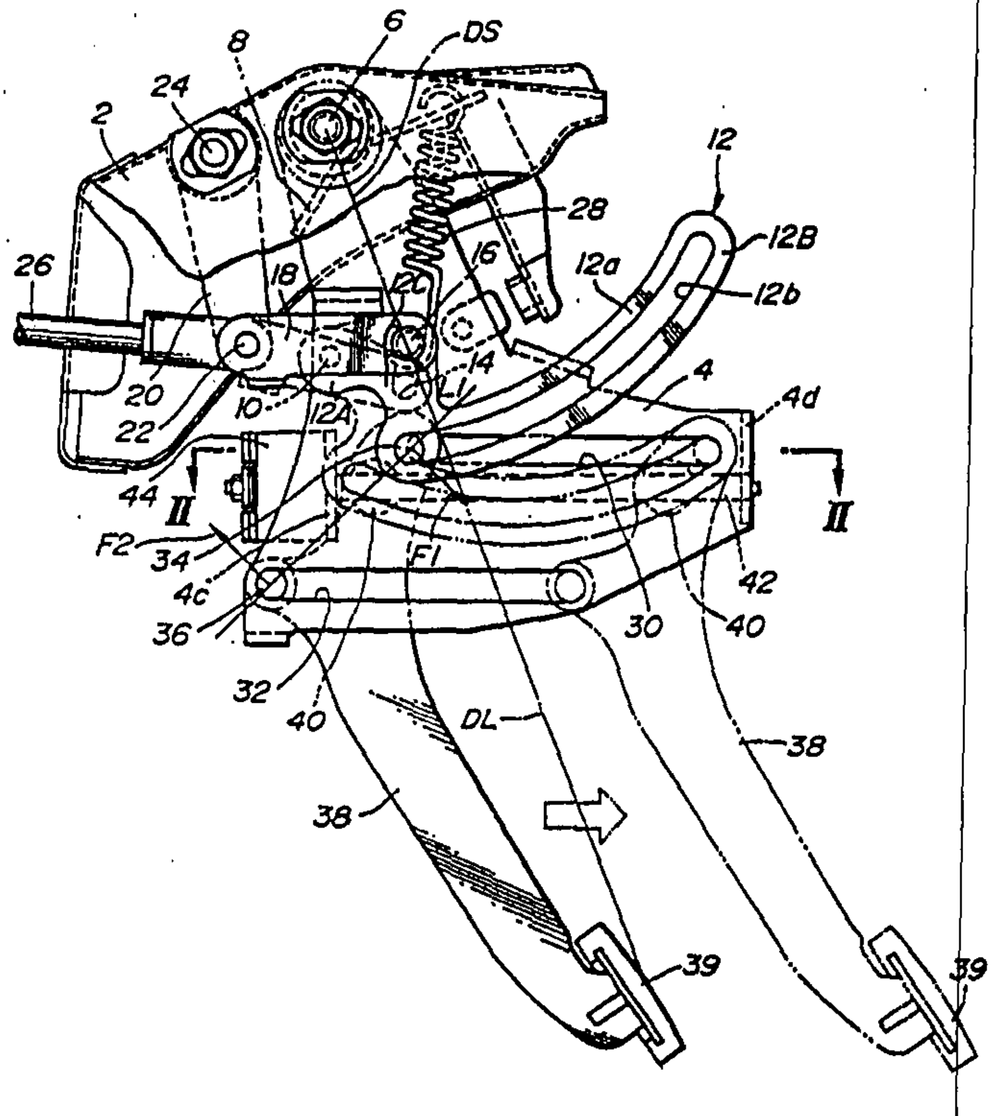
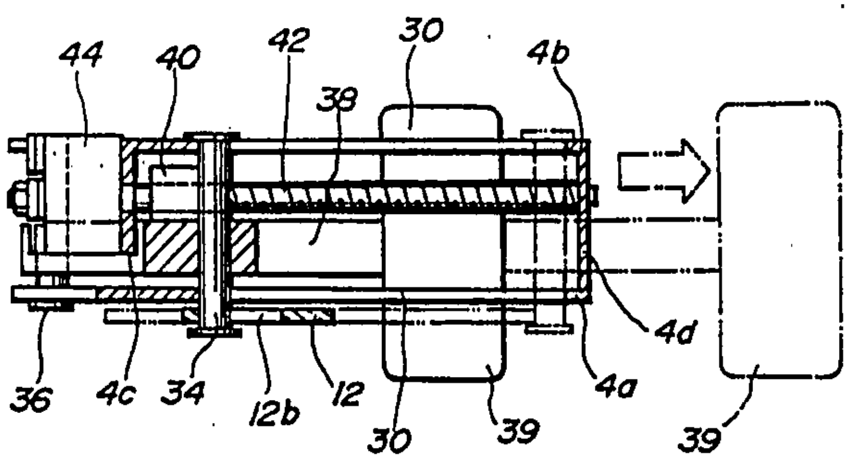


FIG.1



2
24
8
6
DS
28
12
12B
12a
12b
26
18
16
12C
14
4
4d
20
10
12A
22
44
II
II
F2
34
4c
36
F1
42
30
40
32
40
DL
38
38
39
39

FIG.2



44
40
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38
4b
4d
4a
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36
4c
34
12b
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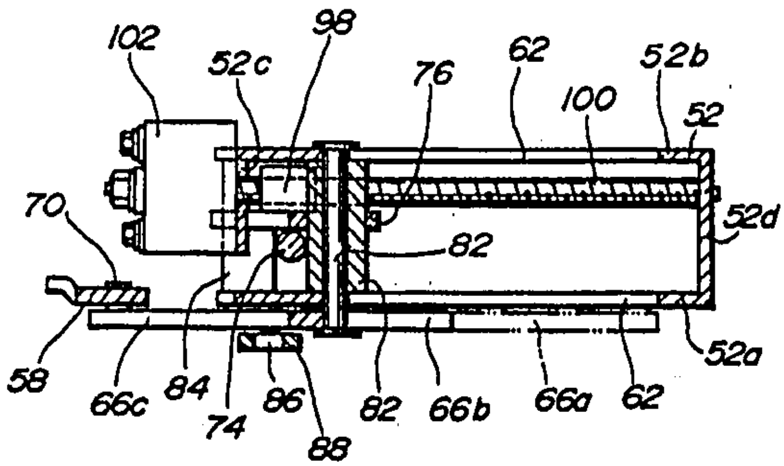
30
39

FIG.6



102
98
52c
76
62
100
52b
52
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52d
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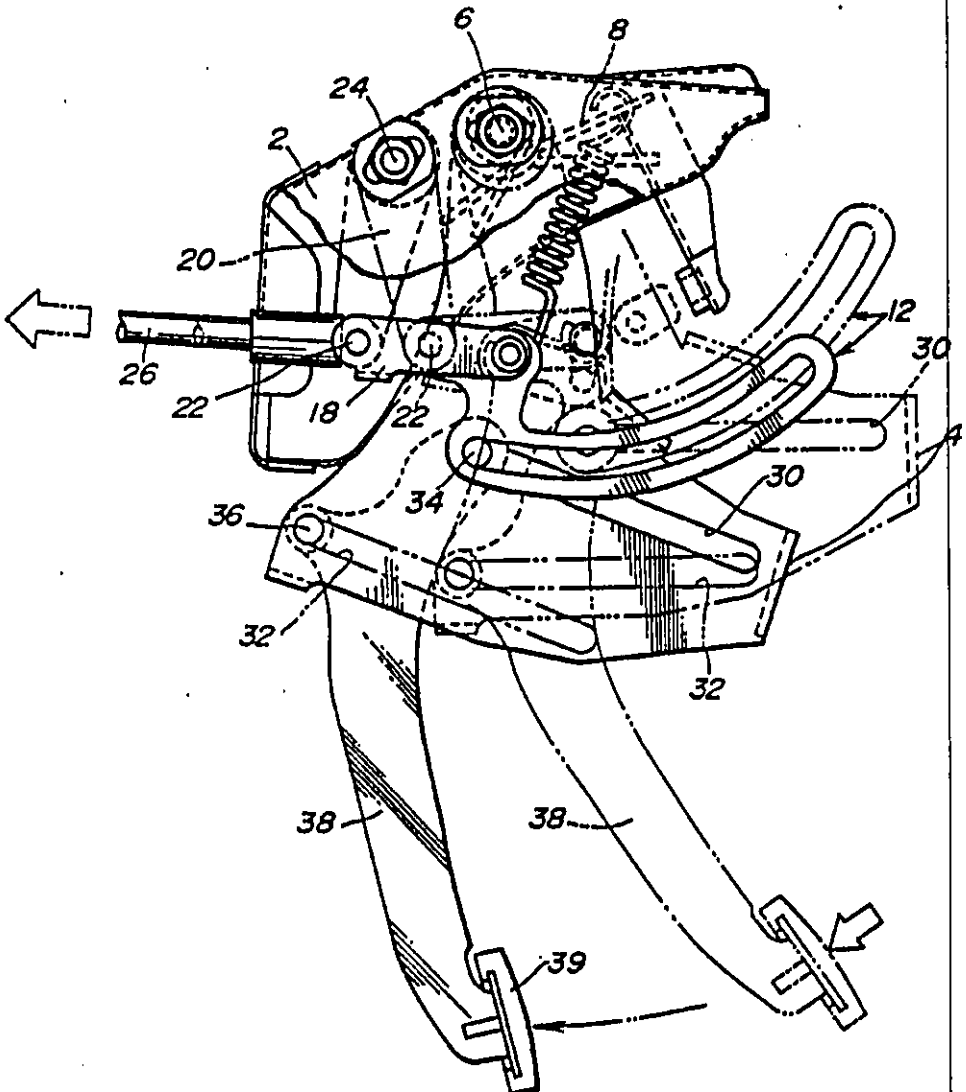
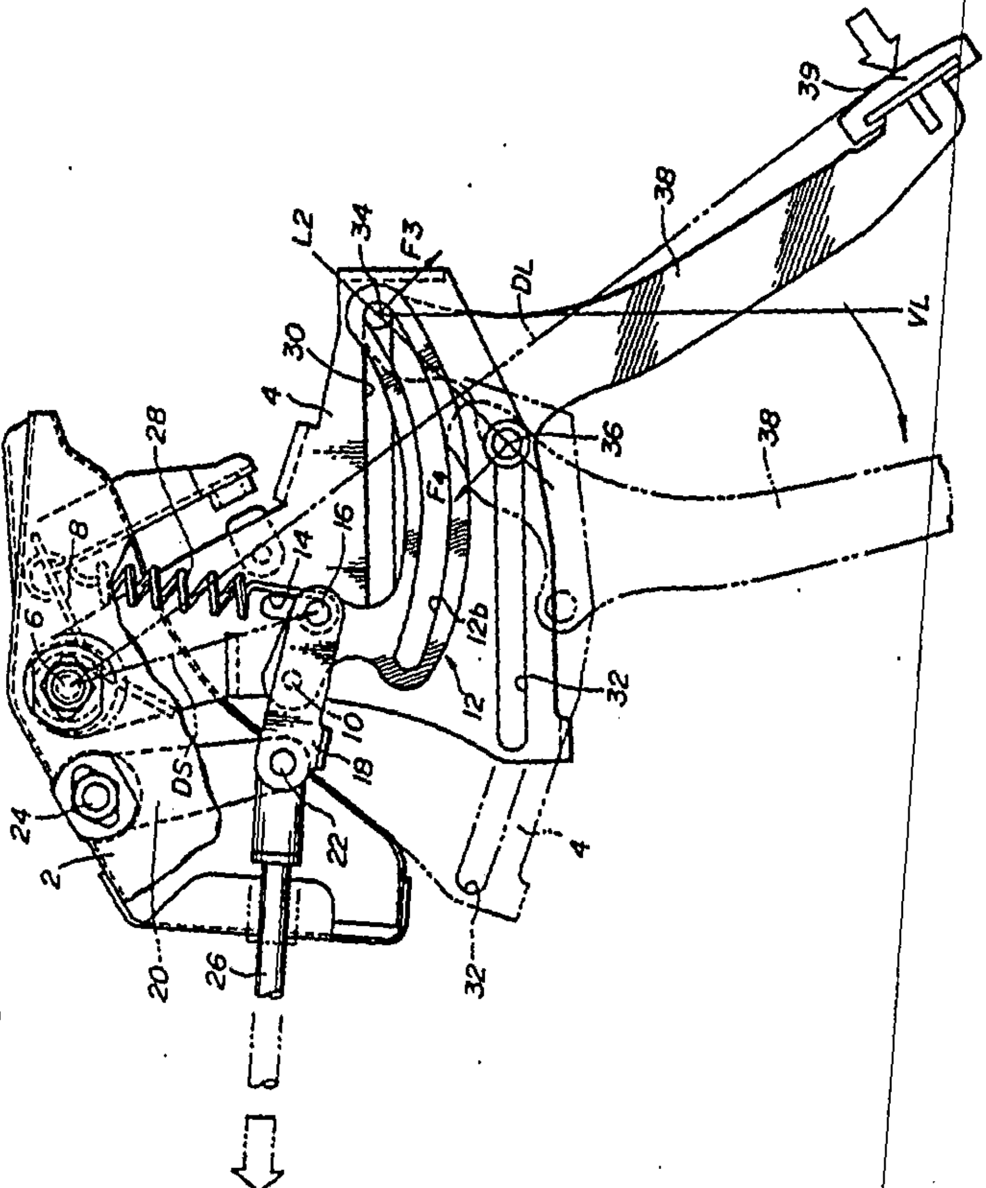
58
66c
84
74
86
88
82
66b
66a
62
52a

FIG. 3

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L2
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F3
DL
VL
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36
38
28
8
16
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F4
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12b
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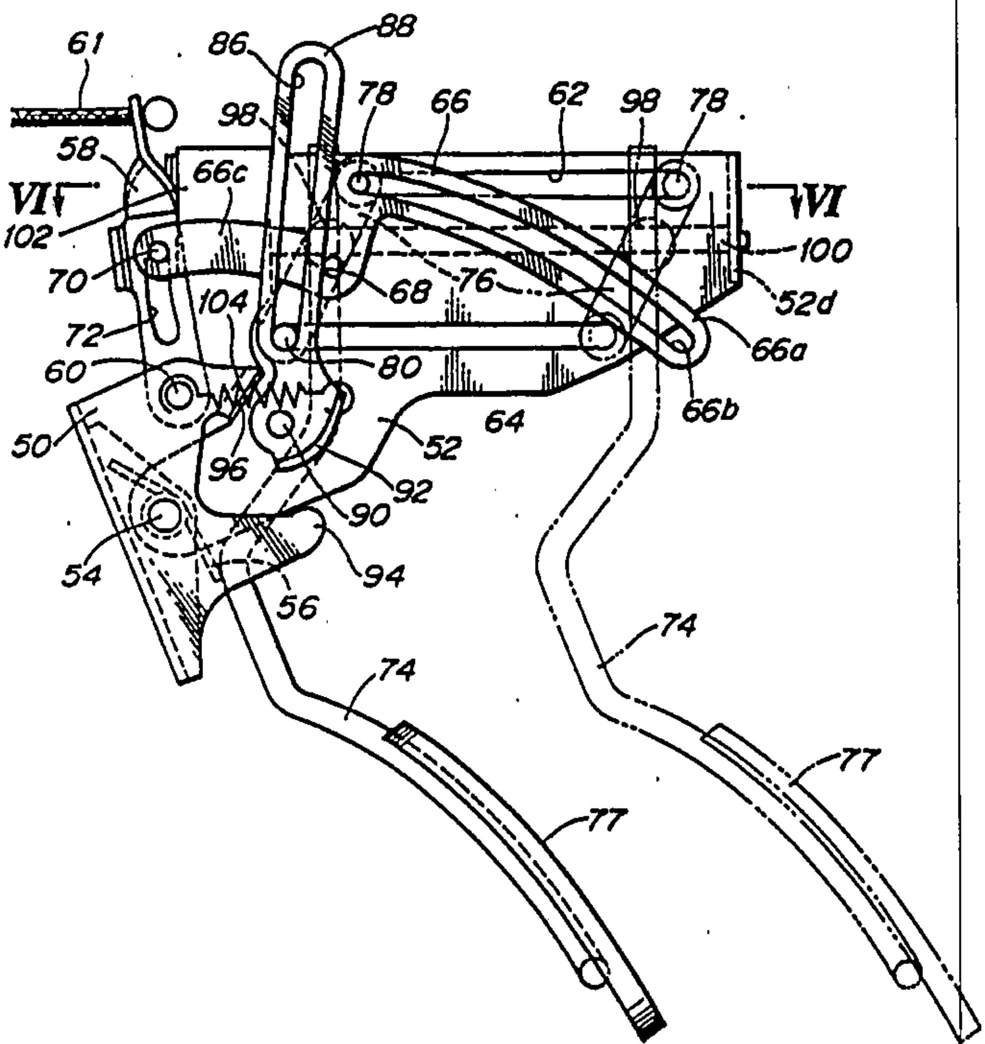
12
10
18
DS
24
22
4
2
20
26
32

FIG. 4

FIG. 5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66c
VI
VI
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52d
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66a
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66b
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52
96
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94
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74
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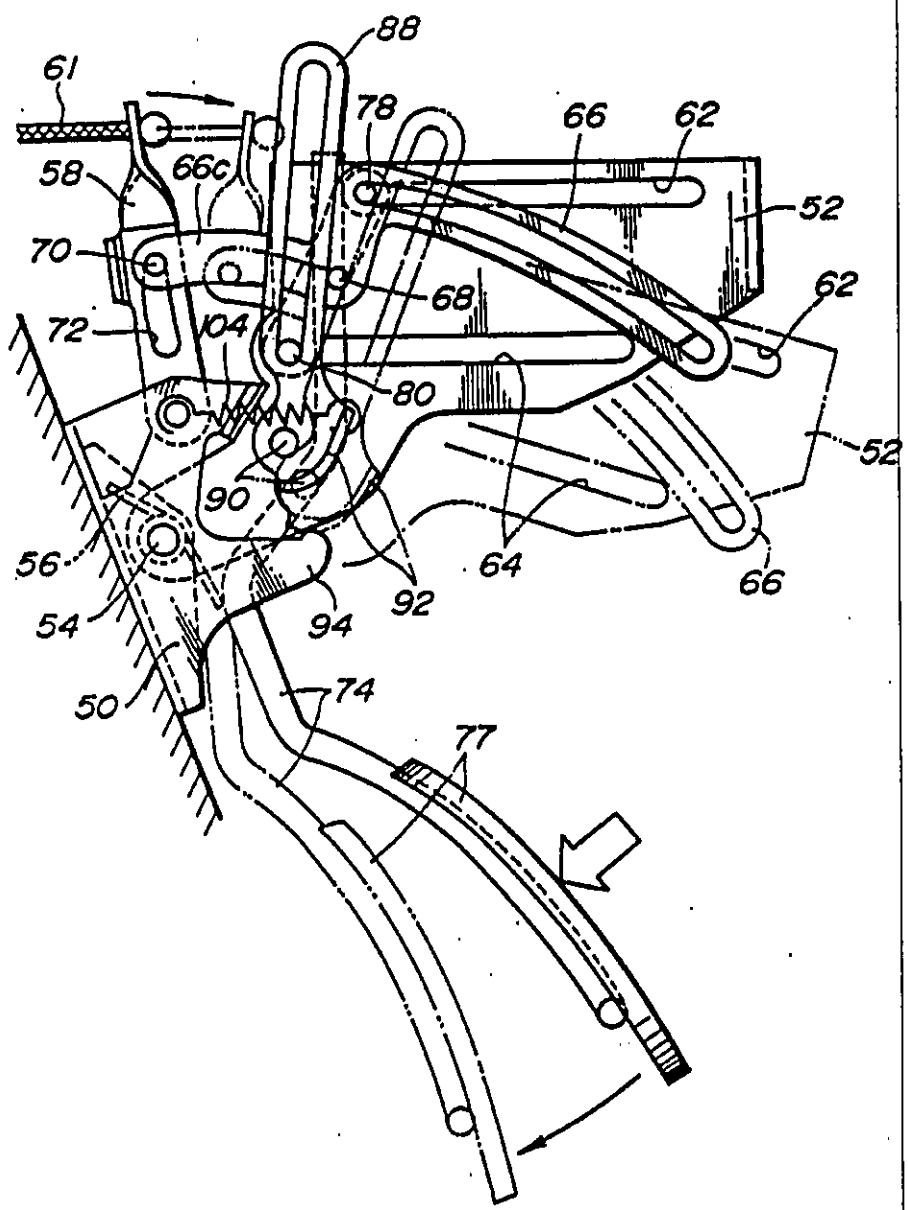
77
77

FIG. 7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66
62
58
66c
52
70
68
62
72
104
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56
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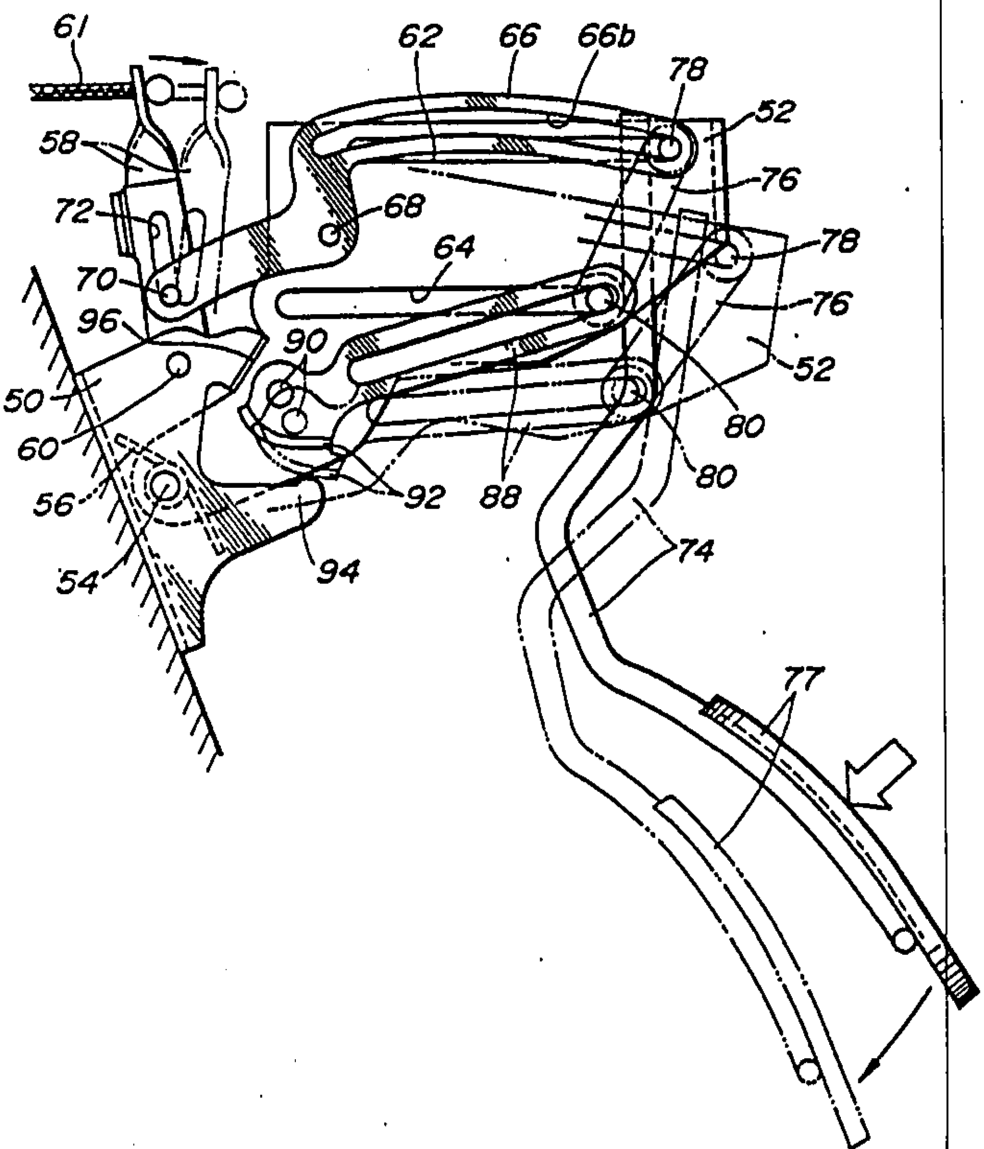
66
54
94
92
74
50
77

FIG.8



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66b
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94
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POSITION ADJUSTABLE PEDAL ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a position adjustable pedal assembly for a vehicle. More specifically, the present invention relates to an automotive position adjustable pedal assembly to be used such as for brake, accelerator and clutch pedals, wherein a position of the pedal is adjustable in the forward and rearward directions of the vehicle.

2. Description of the Background Art

There has been proposed a pedal assembly which enables a driver to adjust a position of the pedal in the forward and rearward directions of the vehicle according to his or her height. This is required since if the driver's seat is adjusted forwardly or rearwardly to match his or her height, the visual field is varied corresponding to the seat position, which is not preferable in view of safety as well as the driving comfortable. Further, if the driver's seat is moved rearwardly, the leg space for a passenger sitting on the rear seat becomes inevitably narrow. Accordingly, there have been required such a pedal assembly which makes it possible to adjust the position of the pedal forwardly and rearwardly.

In the conventional pedal assembly, however, there arises a problem of a variation in force applied to an operating member which is connected to a vehicle operation system, such as a braking system, an engine throttle valve or a clutch system, according to a position of a pedal pad between its adjustable range. Specifically, if an amount or a distance of pivotal displacement of the pedal pad, i.e. of displacement of the pedal pad in the circumferential direction caused by the depression of the pedal pad by the driver is the same, the force applied to the operating member varies according an adjusted position of the pedal pad due to change in a length of a lever between its pivot axis at its upper end and a pedal pad at its lower end where the depression force is applied by the driver.

This variation forces the driver to operate the pedal pad differently according to the adjusted pedal pad position.

SUMMARY OF THE INVENTION

Therefore, it is an object of the present invention to provide a pedal assembly for a vehicle which enables a position of a pedal pad such as a brake pedal pad, an accelerator pedal pad and a clutch pedal pad to be adjusted forwardly and rearwardly of the vehicle, i.e. in a longitudinal direction of the vehicle, wherein a force applied to an operating member which transmits the appled force to a vehicle operation system such as a braking system, an engine throttle valve and a clutch system, is held substantially constant under the same pivotal displacement distance of the pedal pad caused by a driver's depression action of the pedal, irrespective of the adjusted pedal pad position.

Another object of the present invention is to provide a position adjustable pedal assembly, wherein a required depression force or leg power for depressing the pedal pad by the same distance is maintained substantially constant, irrespective of the adjusted pedal pad position.

A further object of the present invention is to provide a position adjustable pedal assembly, wherein a full depression displacement distance of the pedal pad in the circumferential direction is held substantially constant by using adjustable stopper means, irrespective of the adjusted pedal position.

A still further object of the present invention is to provide a position adjustable pedal assembly, wherein a reaction force applied to components of the pedal assembly in the direction along a length of the vehicle, i.e. in the longitudinal direction of the vehicle to be generated in response to the depression force applied to the pedal pad by the driver is considerably reduced so as to attain the strength of the pedal assembly as well as smooth pedal operation feelings.

To accomplish the above-mentioned and other objects, according to one aspect of the present invention, a position adjustable pedal assembly for a vehicle comprises a stationary bracket fixed to a vehicle body, a lever pivotably connected to the stationary bracket about a pivot axis, a pedal arm with a pedal pad at its lower end, the pedal arm being connected to the lever so as to pivot about the pivot axis along with the lever in response to a depression force applied to the pedal pad, first means provided between the lever and the pedal arm for adjusting a position of the pedal pad in a longitudinal direction of the vehicle, second means for transmitting the depression force from the lever to a vehicle operation system, third means provided between the lever and said second means, for varying a point of application of the depressed force relative to said second means from said lever according to an adjusted pedal pad position.

According to a second aspect of the present invention, the third means varies the point of application of the depressed force relative to the second means from the lever in response to variation in a distance between the first pivot axis and a center of the pedal pad.

According to a third aspect of the present invention, the position adjustable pedal assembly may further includes spring means connected to the stationary bracket at its one end and to the lever at its other end, the spring means stretching or compressing in response to the variation of the distance so as to change its spring force applied to the lever and the pedal arm, the change of the spring force absorbing variation in a required depression force to be applied to the pedal pad, the variation of the required depression force being caused by the variation of the distance.

According to a fourth aspect of the present invention, the position adjustable pedal assembly may further include stopper means provided on the lever, the stopper means having an engaging portion of a shape which has a predetermined curvature, said engaging portion being pivotable according to an adjusted pedal pad position so as to contact with the stationary bracket to prevent a pivotal movement of the lever about the pivot axis exceeding a predetermined value in response to a constant pivotal displacement distance of the pedal pad from its non-depressed position irrespective of the adjusted pedal pad position, the predetermined curvature of the engaging portion being non-constant therealong.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given hereinbelow and from the accompanying drawings of the preferred embodiment of the invention, which are given by way of example only, and are not intended to be limitative of the present invention.

In the drawings:

FIG. 1 is a side elevation showing a position adjustable pedal assembly according to a first preferred embodiment of the present invention,

FIG. 2 is a sectional view taken along the line II—II of FIG. 1,

FIG. 3 is a side elevation for showing the operation of the position adjustable pedal assembly of FIG. 1, wherein the pedal pad position is adjusted to its foremost position,

FIG. 4 is a side elevation for showing the operation of the position adjustable pedal assembly of FIG. 1, wherein the pedal pad position is adjusted to its rearmost position,

FIG. 5 is a side elevation showing a position adjustable pedal assembly according to a second preferred embodiment of the present invention,

FIG. 6 is a sectional view taken along the line VI—VI of FIG. 5,

FIG. 7 is a side elevation for showing the operation of the position adjustable pedal assembly of FIG. 5, wherein the pedal pad position is adjusted to its foremost position, and

FIG. 8 is a side elevation for showing the operation of the position adjustable pedal assembly of FIG. 5, wherein the pedal pad position is adjusted to its rearmost position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A first preferred embodiment of a position adjustable pedal assembly will be described with reference to FIGS. 1 to 4, wherein the pedal assembly is applied to a brake pedal.

In FIGS. 1 and 2, a stationary bracket 2 is fixed to a dash panel of a vehicle body. A lever 4 generally of a triangular shape is pivotably connected at its upper end to the stationary bracket 2 with a pivot pin 6 (i.e., a first pivot axis). As can be seen from FIG. 2, the lever 4 is generally of a hollow cubic shape having a right side wall 4*a*, a left side wall 4*b*, a front wall 4*c* and a back wall 4*d*. A return spring 8 is wound onto the pivot pin 6 for urging the lever 4 counterclockwise in FIG. 1 when a depression force is applied by a driver to push the lever 4 clockwise in FIG. 1. A pin 10 is fixedly provided on the right side wall 4*a* of the lever 4 for pivotably supporting an adjust lever 12. The adjust lever 12 includes a first portion 12A extending generally in a forward direction of the vehicle, a second portion 12B extending generally in a rearward direction of the vehicle and a third portion 12C extending generally vertically to connect the first and second portions 12A and 12B. The lever 4 is formed with a pair of first arc-shaped holes or slots 14 (i.e., a first arc-shaped track) at the right and left side walls 4*a* and 4*b*. A first slide pin 16 (i.e., a connecting member) is inserted into the arc-shaped holes 14 for pivotably supporting the adjust lever 12 and one end of a link member 18 on the right side wall 4*a*. The other end of the link member 18 is pivotably connected to an auxiliary lever 20 through a pivot pin 22 (i.e., a second pivot axis). The auxiliary lever 20 is in turn pivotably connected to the stationary bracket 2 through a pivot pin 24. A brake operating rod 26 is pivotably connected at its one end to the pin 22 to be operated in synchronism with displacement of the link member 18. The operating rod 26 is connected at its other end to a vehicle operation system such as a braking system (not shown).

A tension spring 28 is connected at its lower end to the first slide pin 16 and at its upper end to the stationary bracket 2. In FIG. 1, the tension spring 28 is in a balanced position supporting a weight applied to the first slide pin 16. Accordingly, the return spring 8 is not energized when no depression force is applied to the lever 4. The adjust lever 12 is generally of a Z-shape and is formed with a second arc-shaped hole or slot 12*b* (i.e., a second arc-shaped track) at its arc-shaped elongate section 12*a*. A radius of curvature of the arc-shaped hole 12*b* is not constant therealong, which will be described later.

The right side wall 4*a* of the lever 4 is formed with a pair of first and second elongate holes or slots 30 and 32 (i.e., the first and second linear tracks) which extend in parallel to each other in the longitudinal direction of the vehicle. Forward ends as well as rearward ends of the elongate holes 30 and 32 are not vertically aligned, respectively, which will be described later. As can be seen from FIG. 2, the left side wall 4*b* of the lever 4 is also formed with a pair of holes which just correspond to the elongate holes 30 and 32 formed in the right side wall 4*a*. Second and third slide pins 34 and 36 (i.e., the first and second guide member) are slidably inserted into the elongate holes 30 and 32 of the right and left side walls 4*a* and 4*b*, respectively. A pedal arm 38 is inserted into the lever 4 between the right and side walls 4*a* and 4*b* and is supported by the slide pins 34 and 36 at differenct locations. The slide pin 34 further extends through the arc-shaped hole 12*b* of the adjust lever 12. The pedal arm 38 is provided with a pedal pad 39 at its lower end.

A screw nut 40 (i.e., a driven member) is fixed to the pedal arm 38 and a corresponding screw rod 42 (i.e., a drive member) is rotatably mounted to the front and back walls 4*c* and 4*d*. The screw nut 40 is of a cylindrical shape and formed with a threaded hole through which the screw rod 42 extends so as to be engaged with each other. An electric motor 44 is fixed to the front wall 4*c* and is connected to the screw rod 42 for actuating same. Specifically, the motor 44 is energized to rotate in the normal or reverse direction in response to the driver's switching operation. This rotation of the motor causes the screw rod 42 to rotate in the same direction with the motor 42. The screw nut 40 is guided by the rotation of the screw rod 42 to move along the screw rod 42. This movement of the screw nut 40 causes the pedal arm 38 along with the pedal pad 39 to move along the secrew rod 42, with the slide pins 34 and 36 each moving within the corresponding hole 30 or 32 between its forward and rearwad ends, as shown in FIG. 1 by the solid and dotted lines.

Now the operation of the first preferred embodiment will be described hereinbelow.

FIG. 3 shows the operation of the position adjustable pedal assembly, wherein the pedal pad 39 is adjusted to its foremost position. Specifically, the slide pins 34 and 36 are positioned at the forward ends of the elongate holes 30 and 32, respectively, and the slide pin 34 is also positioned at the forward end of the arc-shaped hole 12*b*. When the pedal pad 39 is depressed by the driver, as shown by the solid line in FIG. 3, the pedal arm 38 and the lever 4 pivot about the pivot pin 6 as one integral unit in the clockwise direction. This causes the link member 18 to move forwardly so as to rotate the auxiliary lever 20 about the pivot pin 24 in the clockwise direction. Accordingly, the pin 22 is displaced forwardly to push the operating rod 26 also forwardly so

as to transmit the depressed force applied to the brake pedal pad 39 to the vehicle operation system (not shown) through the operating rod 26.

It is to be noted that since a line L1 is inclined at a predetermined angle to the vertical line VL, force F1 and F2 is applied to the slide pins 34 and 36 as shown in FIG. 1 in response to the depressing force applied to the brake pedal pad 39. Accordingly, the force which is to be applied to the slide pins 34 and 36 in a longitudinal direction of the elongate holes 30 and 32 is considerably reduced. On the other hand, if the slide pins 34 and 36 are vertically aligned, the force F1 and F2 is applied to the slide pins 34 and 36 in the direction along the length of the elongate holes 30 and 32. Accordingly, the strength of the assembly becomes less and the operation of the pedal pad 39 becomes jerky since the slide pin 34 is not engaged with any member in the direction along the force F1.

When the brake pedal pad 39 is released from the depression force, the pedal arm 38 and the lever 4 return to the initial position as one integral unit by means of the energized force of the return spring 8 as shown by the dotted line in FIG. 3.

In order to adjust the pedal position away from the foremost position as shown in FIG. 3 to, for example, the rearmost position, the electric motor 44 is energized to rotate in the normal direction by operating the switch (not shown), which causes the screw rod 42 to rotate in the same direction. Accordingly, the screw nut 40 moves along the screw rod 42 rearwardly to slide the slide pins 34 and 36 within the corresponding elongate holes 30 and 32 also rearwardly, as shown by the solid line in FIG. 4 wherein the pedal position is adjusted to its rearmost position. Simultaneously, the slide pin 34 slides within the arc-shaped hole 12*b* from its forward end to its rearward end, which causes the adjust lever 12 to pivot about the pin 10 in the clockwise direction. This pivotal movement of the adjust lever 12 causes the support pin 16 to move downward within the arc-shaped hole 14. Simultaneously, the link member 18 pivots about the pin 22 in the clockwise direction, which, however, does not cause the auxiliary lever 20 to pivot about the pivot pin 24, i.e. the pin 22 does not move so that no force is applied to the operating rod 26 since a radius of curvature of the arc-shaped hole 14 is the same as a distance between the center of the pin 22 and the center of the support pin 16.

As described before, the radius of curvature of the arc-shaped hole 12*b* is not constant therealong. Specifically, the radii of curvature of the arc-shaped hole 12*b* are selected such that when the first slide pin 16 moves downward or upward within the arc-shaped hole 14 in response to the sliding movement of the slide pin 34 within the arc-shaped hole 12*b* toward its rearward end or its forward end, respectively, a ratio of a distance DS to a distance DL is maintained constant, wherein the distance DS is a distance between the center of the pivot pin 6 and the center of the first slide pin 16 and the distance DL is a distance between the center of the pivot pin 6 and the center of the pedal pad 39. This ratio is maintained constannt irrespective of the position of the slide pin 34 within the arc-shaped hole 12*b*. Accordingly, the force applied to the operating rod 26 and the required depression force or the leg power are kept constant irrespective of the adjusted pedal position under a condition that a distance of the pivotal displacement of the pedal pad 39 from the non-depressed position is the same.

Though the change in the distance DL causes a change in its center of gravity, which varies the required depression force or leg power, this variation is absorbed by means of the tension spring 28 which stretches or compressed according to the position of the first slide pin 16.

As seen from FIG. 4, when the pedal pad 39 is depressed by the driver, the pedal arm 38 and the lever 4 pivot about the pivot pin 6 as one integral unit in the clockwise direction to move the link member 18 forward. Simultaneously, the pin 22 moves forward and the auxiliary lever 20 pivots about the pivot pin 24, so that the applied depression force is transmitted to the operating rod 26.

As seen from FIG. 4, a line L2 is inclined at the predetermined angle to the vertical line VL and force F3 and F4 is applied to the slide pins 34 and 36, respectively. This arrangement provides the same effect as described before with reference to FIGS. 1 and 3.

When the pedal pad 39 is released from the depression force, the pedal arm 38 and the lever 4 return to the initial or the non-depressed position as shown by the solid line by means of the energized force of the return spring 8.

In order to return the pedal arm 38 to the position as shown by the solid line in FIG. 1, the electric motor 44 is energized to rotate in the reverse direction.

Now a second preferred embodiment of the position adjustable pedal assembly will be described with reference to FIGS. 5 to 8, wherein the pedal assembly is applied to an accelerator pedal.

In FIGS. 5 and 6, a stationary bracket 50 is fixed to a dash panel of the vehicle body. A lever 52 is pivotably connected to the stationary bracket 50 by a pivot pin 54 (i.e., a first pivot axis). As can be seen from FIG. 6, the lever 52 is generally of a hollow cubic shape having a right side wall 52*a*, a left side wall 52*b*, a front wall 52*c* and a back wall 52*d*. A return spring 56 is wound onto the pivot pin 54 for urging the lever 52 counterclockwise in FIG. 5 when a depression force is applied by the driver to push the lever 52 in the clockwise direction.

An operating lever 58 is pivotably connected to the stationary bracket 50 by means of a pivot pin 60 at its lower end and is connected to an operating wire 61 at its upper end. The operating wire is in turn connected to a throttle valve of a vehicle operation system (not shown). The lever 52 is formed with a pair of elongate holes 62 and 64 (i.e., a first and second linear tracks) just as in the first preferred embodiment. An adjust lever 66 is pivotably mounted to the lever 52 by means of a pin 68 which is fixed to the right side wall 52*a* of the lever 52. The adjust lever 66 is generally of a reversed-Z-shape and is formed with an arc-shaped hole or slot 66*b* (i.e., a second arc-shaped track) at its arc-shaped section 66*a*. A radius of curvature of the arc-shaped hole 66*b* is not constant, which will be described later. The adjust lever 66 has another arc-shaped section 66*c* which extends in the forward direction and is provided at its forward end with a slide pin 70 (i.e., a connecting member) which engages with an arc-shaped hole or slot 72 (i.e., a first arc-shaped track). A radius of curvature of the arc-shaped hole 72 is the same as a distance between the center of the pin 68 and the center of the slide pin 70 so as to prevent the operating lever 58 from pivoting about the pivot pin 60 when the adjust lever 66 is pivoted about the pin 68 for adjusting the pedal position, which will be described later.

A pedal arm 74 is inserted into the lever 52 between the right and left side walls 52a and 52b and is provided with a bracket 76 at its upper portion. The pedal arm 74 is provided with an accelerator pedal pad 77. The bracket 76 is fixed to the pedal arm 74 and is provided with a pair of slide pins 78 and 80 (i.e., the first and second guide member) at its upper and lower ends, respectively. Collars 82 and 84 are placed between the bracket 76 and the corresponding slide pins 78 and 80 as shown in FIG. 6. The slide pin 78 is inserted through the elongate holes 62 of the lever 52 and further through the arc-shaped hole 66b of the adjust lever 66. The slide pin 80 is inserted through the elongate holes 64 of the lever 52 and further through an elongate hole 86 formed in a stopper lever 88 which is pivotably connected to the lever 52 through a pivot pin 90. The elongate hole 86 is long enough to allow the the slide pin 80 to move within the elongate hole 64 between its forward and rearward ends. The stopper lever 88 is formed with an engaging portion 92 at a side opposite to the elongate hole 86 with respect to the pivot pin 90. The engaging portion 92 is engageable with an arc-shaped projection 94 of the stationary bracket 50, which projection 94 is formed at a lower rearward end of the stationary bracket 50. The engagement of the engaging portion 92 with the arc-shaped projection 94 prevents a clockwise pivotal movement of the lever 52 exceeding a predetermined value which is caused by the depression force applied by the driver. Curvature of the engaging portion 92 is not constant therealong. Specifically, the curvature of the engaging portion 92 is selected such that the engaging portion 92 engages with the arc-shaped projection 94 to stop the clockwise pivotal movement of the lever 52 exceeding the predetermined value in response to a constant distance of the pivotal displacement of the pedal pad 77 irrespective of the adjusted position of the pedal pad 77. The stationary bracket 50 is further formed with a stopper projection 96 at its upper rearward end. The stopper projection 96 is engageable with a corresponding forward end of the lever 52 so as to prevent a counterclockwise pivotal movement of the lever 52 exceeding a predetermined value.

A screw nut 98 (i.e., a driven member) is fixed to the bracket 76 and a corresponding screw rod 100 (i.e., a drive member) is rotatably mounted to the front and back walls 52c and 52d. The screw nut 98 is of a cylindrical shape and formed with a threaded hole through which the screw rod 100 extends so as to be engaged with each other. An electric motor 102 is fixed to the front wall 52c and is connected to the screw rod 100 for actuating same. Specifically, the motor 102 is energized to rotate in the normal or reverse direction in response to the driver's switching operation. This rotation of the motor causes the screw rod 100 to rotate in the same direction with the motor 102. The screw nut 98 is guided by the rotation of the screw rod 100 to move along the screw rod 100. This movement of the screw nut 98 causes the bracket 76, i.e. the pedal arm 74 along with the pedal pad 77 to move along the secrew rod 100, with the slide pins 78 and 80 each moving within the corresponding hole 62 or 64 between its forward and rearwad ends, as shown in FIG. 5 by the solid and dotted lines.

A tension spring 104 is connected to the pivot pin 60 at its forward end and to the stopper lever 88 at its rearward end. The tension spring 104 is in a balanced position supporting a weight applied to the tension spring 104.

Now the operation of the second preferred embodiment will be described hereinbelow.

FIG. 7 shows the operation of the position adjustable pedal assembly, wherein the pedal pad 77 is adjusted to its foremost position. Specifically, the slide pins 78 and 80 are positioned at the forward ends of the elongate holes 62 and 64, respectively, and the slide pin 78 is also positioned at the forward end of the arc-shaped hole 66b. When the pedal pad 77 is depressed by the driver, as shown by the dotted line in FIG. 7, the pedal arm 74 and the lever 52 pivot about the pivot pin 54 as one integral unit in the clockwise direction. Simultaneously, the adjust lever 66 pulls the operating lever 58 so that the operating lever 58 pivots about the pivot pin 60 in the clockwise direction to pull the operating wire 61 in the rearward direction, which in turn operates the throttle valve of the vehicle operation system (not shown).

When the clockwise pivotal movement of the lever 52 and the pedal arm 74 exceeds the predetermined value, the engaging portion 92 of the stopper lever 88 engages with the arc-shaped projection 94 of the stationary bracket 50 to prevent the further pivotal movement of the lever 52 and the pedal arm 74. On the other hand, when the depression force is released, the lever 52 and the pedal arm 74 pivot about the pivot pin 54 counterclockwise by means of the energized force of the return spring 56 to return to the initial position as shown by the solid line in FIG. 7.

In order to adjust the pedal position away from the foremost position as shown in FIG. 7 to, for example, the rearmost position, the electric motor 102 is energized to rotate in the normal direction by operating the switch (not shown), which causes the screw rod 100 to rotate in the same direction. Accordingly, the screw nut 98 moves along the screw rod 100 rearwardly to slide the slide pins 78 and 80 through the bracket 76 within the corresponding elongate holes 62 and 64 also rearwardly, as shown by the solid line in FIG. 8 wherein the pedal position is adjusted to its rearmost position. Simultaneously, the slide pin 78 slides within the arc-shaped hole 66b from its forward end to its rearward end, which causes the adjust lever 66 to pivot about the pin 68 in the counterclockwise direction. This pivotal movement of the adjust lever 66 causes the the slide pin 70 to move downward within the arc-shaped hole 72. The sliding movement of the slide pin 70 within the arc-shaped hole 72 does not cause the operating lever 58 to pivot about the pivot pin 60 so that no force is applied to the operating wire 61 since a radius of curvature of the arc-shaped hole 72 is the same as a distance between the center of the slide pin 70 and the center of the pivot pin 68.

As described before, the radius of curvature of the arc-shaped hole 66b is not constant therealong. Specifically, the radii of curvature of the arc-shaped hole 66b are selected such that when the slide pin 70 moves downward or upward within the arc-shaped hole 72 in response to the sliding movement of the slide pin 78 within the arc-shaped hole 66b toward its rearward end or its forward end, respectively, a distance between the center of the pivot pin 60 and the center of the slide pin 70 becomes in reverse proportion to a distance between the center of the pivot pin 54 and the center of the pedal pad 77. Accordingly, the force applied to the operating wire 61 and the required depression force or the leg

power are kept constant irrespective of the ajusted pedal position under a condition that a distance of the pivotal displacement of the pedal pad 77 from the non-depressed position is the same.

As the slide pin 80 moves rearward within the elongate hole 64, the stopper lever 88 starts to pivot about the pivot pin 90 in the clockwise direction, which causes the engaging portion 92 also to pivot about the pivot pin 90. As described before, the curvature of the engaging portion 92 is not constant therealong. Specifically, the curvature of the engaging portion 92 is selected to allow the engaging portion 92 to contact with the arc-shaped projection 94 when the pedal pad 77 performs a pivotal displacement of a predetermined constant distance from the non-depressed position of the pedal pad 77, irrespective of an adjusted pedal position.

As seen from FIG. 8, when the pedal pad 77 is depressed by the driver, the pedal arm 74 and the lever 52 pivot about the pivot pin 54 as one integral unit in the clockwise direction to actuate the operating lever 58 through the adjust lever 66. Accordingly, the operating lever 58 pivots about the pivot pin 60 clockwise to pull the operating wire 61 rearwardly, so that the throttle valve of the vehicle operation system is in turn actuated. The pivotal movement of the lever 52 and the pedal arm 74 exceeding the predetermined value is prevented by means of the engagement between the engaging portion 92 and the arc-shaped projection 94. When the pedal pad 77 is released from the depression force, the pedal arm 74 and the lever 52 pivot about the pivot pin 54 counterclockwise to return to the initial or non-depressed position as shown by the solid line in FIG. 8 by means of the energized force of the return spring 56. A further counterclockwise movement is prevented by means of the engagement between the stopper projection 96 and the forward end of the lever 52.

In order to return the pedal arm 74 to the position as shown by the solid line in FIG. 5, the electric motor 102 is energized to rotate in the reverse direction.

As in the first preferred embodiment, the center of the slide pin 78 and the center of the slide pin 80 are not vertically aligned, which can provide the same effect as described in the first preferred embodiment.

It is to be understood that the invention is not to be limited to the embodiments described above, and that various changes and modifications may be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A position adjustable pedal assembly for a vehicle comprising:

- a stationary bracket fixed to a stationary portion of the vehicle;
- a lever connected to said stationary bracket for a pivotal movement relative to said stationary bracket about a first pivot axis;
- a pedal arm with a pedal pad at its lower end, said pedal arm connected to said lever for pivotal movement with said lever as one integral unit in response to a depression force applied to the pedal pad;
- pedal position adjusting means including a drive member and a driven member, said drive member adapted to be activated by a vehicle driver's operation, said driven member mounted on said pedal arm to be selectively driven by said drive member to move in a longitudinal direction of the vehicle along with said pedal arm relative to said lever so as to adjust a position of the pedal pad in the longitudinal direction of the vehicle;
- an adjust lever provided on said lever, said adjust lever being allowed a relative movement to said lever and having a connecting member which is adapted to move within a first arc-shaped track in response to the relative movement of said adjust lever;
- a second arc-shaped track formed on said adjust lever;
- a first linear track formed on said lever and extending in the longitudinal direction of the vehicle;
- a first guide member provided on said pedal arm, said first guide member adapted to move within said first linear track, and simultaneously within said second arc-shaped track formed on said adjust lever when said pedal arm is driven to move in the longitudinal direction of the vehicle via said pedal position adjusting means, said movement of the first guide member changing a distance from said first pivot axis to said pedal pad corresponding to a magnitude of the movement of said first guide member and simultaneously allowing said relative movement of the adjust lever to change a position of said connecting member within said first arc-shaped track corresponding to said magnitude of the movement of said first guide member; and
- operating member means connected to said connecting member for receiving therefrom the depression force applied to said pedal pad via said pedal arm and said lever and for transmitting said depression force to a vehicle operation system to operate same.

2. The position adjustable pedal assembly as set forth in claim 1, wherein said relative movement of the adjust lever changes the position of said connecting member to provide a predetermined ratio relationship between said distance and a distance from said first pivot axis to said connecting member.

3. The position adjustable pedal assembly as set forth in claim 2, wherein said drive member includes a screw rod rotatably supported on said lever and extending in parallel to said first linear track, and said driven member includes a nut fixed to said pedal arm and having a threaded hole therethrough which receives said screw rod therethrough for mutual engagement therebetween, said nut being allowed to move in the longitudinal direction of the vehicle along with said pedal arm when said screw rod is actuated to rotate.

4. The position adjustable pedal assembly as set forth in claim 2, wherein said connecting member includes a first slide pin connected to said adjust lever, and said first arc-shaped track includes a first arc-shaped slot formed in said lever, said first slide pin being allowed to slide within said first arc-shaped slot in response to said relative movement of the adjust lever.

5. The position adjustable pedal assembly as set forth in claim 4, wherein said first pivot axis is provided at an upper end of said lever, and said first arc-shaped slot is oriented substantially in a vertical direction to provide said predetermined ratio relationship in which a ratio between said distance from the first pivot axis to the pedal pad and said distance from the first pivot axis to the first slide pin is maintained constant irrespective of an adjusted position of the pedal pad which is adjusted by said pedal position adjusting means.

6. The position adjustable pedal assembly as set forth in claim 5, further comprising spring means connected to said stationary bracket at its upper end and to said first slide pin at its lower end, said spring means stretching or compressing in response to said movement of said first slide pin within said first arc-shaped slot so as to change its spring force applied to said pedal pad via said slide pin, said lever and said pedal arm, said change of the spring force absorbing variation in a required depression force to be applied to said pedal pad, said variation in the required depression force being caused by variation in said distance from the first pivot axis to the pedal pad due to the adjustment of the pedal pad position via said pedal position adjusting means.

7. The position adjustable pedal assembly as set forth in claim 5, wherein said operating member means includes a link member and an operating rod, said link member being connected to said first slide pin at its rearward end and connected to said operating rod at its forward end for a pivotal movement relative to said operating rod about a second pivot axis, and wherein said first arc-shaped slot has a radius of curvature which is the same as a distance from the first slide pin to said second pivot axis for preventing displacement of the operating rod while the first slide pin moves within said first arc-shaped slot due to the adjustment of said pedal pad by means of said pedal position adjusting means.

8. The position adjustable pedal assembly as set forth in claim 7, wherein radii of curvature of said second arc-shaped track formed on said adjust lever are preselected to maintain said distance ratio to be constant irrespective of a position of said first guide member within said second arc-shaped track.

9. The position adjustable pedal assembly as set forth in claim 8, wherein said first guide member is a second slide pin which is fixed to said pedal arm at its portion opposite to said pedal pad, and said first linear track is a first linear slot which is formed in said lever, and wherein said second slide pin is engaged into said first linear slot and further into said second arc-shaped slot formed in said adjust lever.

10. The position adjustable pedal assembly as set forth in claim 9, further comprising a second guide member in a form of a third slide pin fixed to said pedal arm below said second slide pin, said second and third slide pins being vertically disaligned from each other, and a second linear track in a form of a second linear slot formed in said lever below said first linear slot, said first and second linear slots extending in parallel to each other vertically disaligned from each other, said third slide pin being engaged into said second linear slot for a sliding movement therewithin when said pedal arm is driven to move in the longitudinal direction of the vehicle.

11. A position adjustable pedal assembly for a vehicle comprising:

- a stationary bracket fixed to a stationary portion of the vehicle;
- a lever connected to said stationary bracket for a pivotal movement relative to said stationary bracket about a first pivot axis;
- a pedal arm with a pedal pad at its lower end, said pedal arm connected to said lever for pivotal movement with said lever as one integral unit in response to a depression force applied to the pedal pad;
- pedal position adjusting means including a drive member and a driven member, said drive member adapted to be activated by a vehicle driver's operation, said driven member mounted on said pedal arm to be selectively driven by said drive member to move in a longitudinal direction of the vehicle along with said pedal arm relative to said lever so as to adjust a position of the pedal pad in the longitudinal direction of the vehicle;
- an adjust lever being generally of a Z-shape having a first portion extending generally in a forward direction of the vehicle, a second portion extending generally in a rearward direction of the vehicle and a third portion extending generally vertically to connect said first and second portions, said first portion being connected to said lever at its forward end for a pivotal movement relative to said lever and being connected to a first slide pin at its rearward end, said first slide pin engaging into a first arc-shaped slot formed in said lever for sliding movement therewithin in response to the pivotal movement of said first portion, said second portion being formed with a second arc-shaped slot having a predetermined curvature;
- operating member means including a link member and an operating rod, said link member being pivotally connected to said first slide pin at its rearward end and pivotably connected to said operating rod at its forward end for receiving the depression force from said first slide pin and for transmitting the depression force to said operating rod to operate a vehicle operation system; and
- said pedal arm provided with a second slide pin at its upper portion which is inserted into a first elongate slot formed in said lever and extending in the longitudinal direction of the vehicle, and into said second arc-shaped slot such that when said second slide pin slides within said first elongate slot and said second arc-shaped slot in the longitudinal direction of the vehicle so as to adjust the pedal pad position, the cooperation of the second slide pin and the second arc-shaped slot forces said first slide pin to slide within said first arc-shaped slot so as to vary a point of application of the depressed force relative to said link member via said first slide pin, said first arc-shaped slot having a predetermined curvature such that the sliding movement of said first slide pin within said first arc-shaped slot is prevented from displacing said operating rod.

12. The position adjustable pedal assembly as set forth in claim 11, wherein said lever is further formed with a second elongate slot below said first elongate slot, said second elongate slot extending in parallel to said first elongate slot, forward and rearward ends of said first and second elongate slots are vertically disaligned, respectively, and said pedal arm is further provided with a third slide pin below said second slide pin, said third slide pin being inserted into said second elongate slot for sliding movement therewithin, said second and third slide pins being vertically disaligned from each other.

* * * * *

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United States Patent [19]

Rixon et al.

[11] Patent Number: 5,819,593

[45] Date of Patent: *Oct. 13, 1998

[54] ELECTRONIC ADJUSTABLE PEDAL ASSEMBLY

[75] Inventors: Christopher J. Rixon, Tecumseh, Canada; Christopher Bortolon, Clawson, Mich.

[73] Assignee: Comcorp Technologies, Inc., Warren, Mich.

[*] Notice: The term of this patent shall not extend beyond the expiration date of Pat. No. 5,632,183.

[21] Appl. No.: 516,050

[22] Filed: Aug. 17, 1995

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 513,017, Aug. 9, 1995, Pat. No. 5,632,183.

[51] Int. Cl.[6] G05G 1/14

[52] U.S. Cl. 74/514; 74/513

[58] Field of Search 74/514, 513, 512, 74/560

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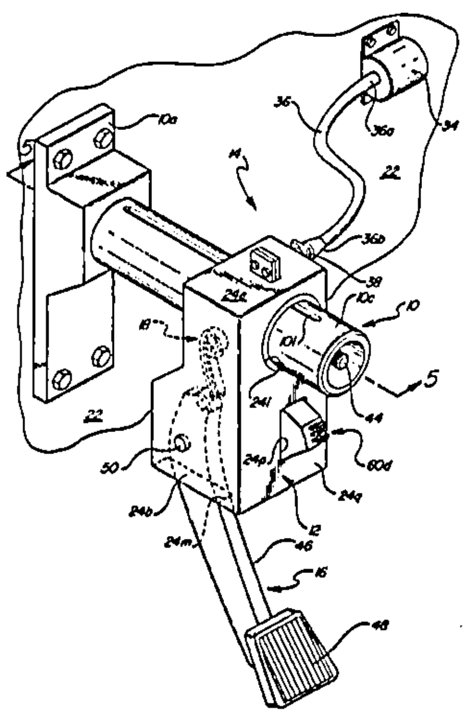
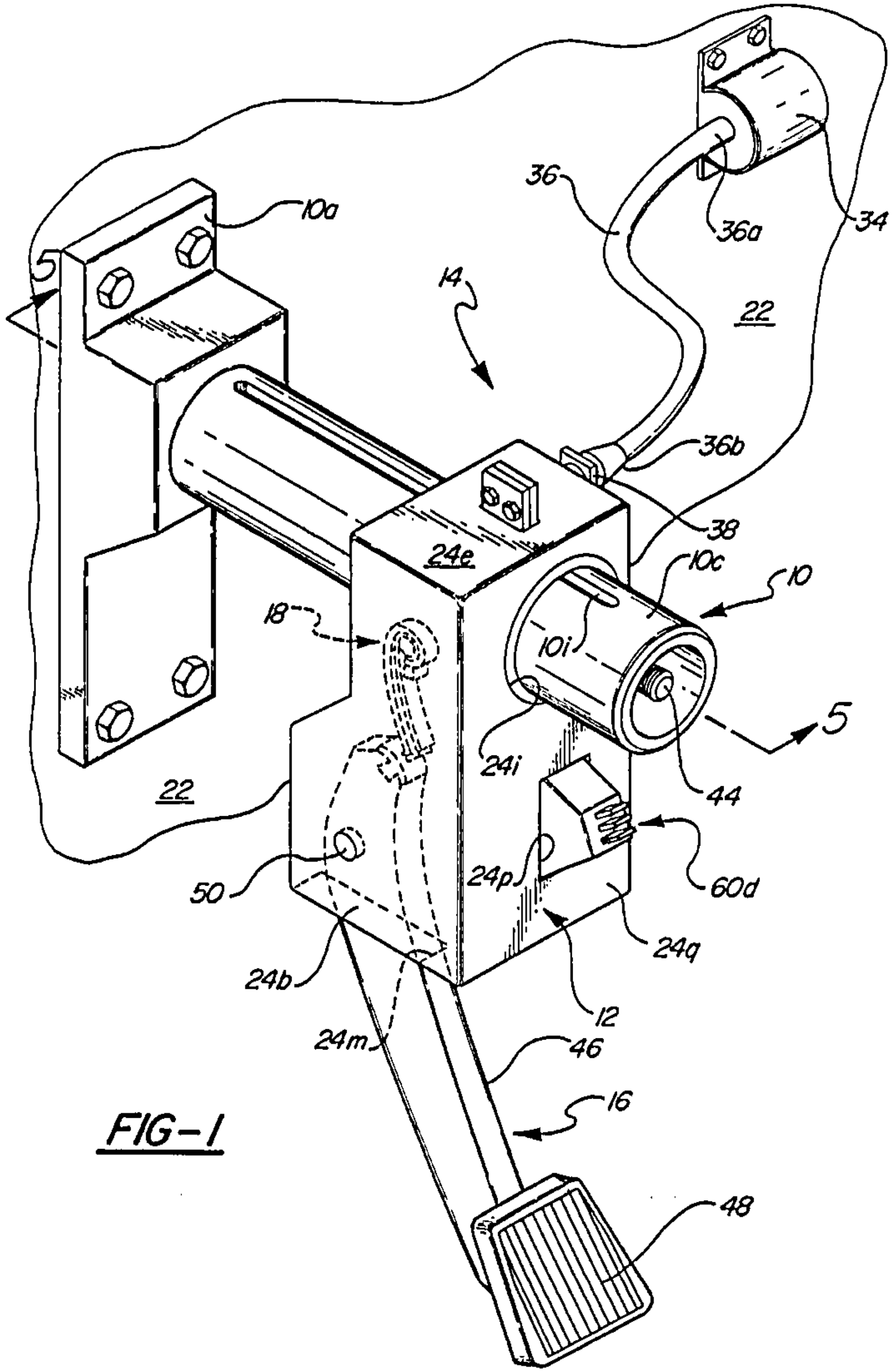
Primary Examiner—Charles A. Marmor
Assistant Examiner—MaryAnn Battista
Attorney, Agent, or Firm—Howard & Howard

[57] ABSTRACT

An electronic adjustable control pedal assembly for a motor vehicle including a carrier, a guide rod adapted to be secured to the dash panel of the vehicle and mounting the carrier for fore and aft movement along the guide rod, a power drive operative to move the carrier along the guide rod, and a pedal structure including a pedal arm pivotally mounted on the carrier and a potentiometer mounted on the carrier and operative to generate an output electrical signal proportioned to the extent of pivotal movement of the pedal arm.

4 Claims, 4 Drawing Sheets





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36a
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FIG-1

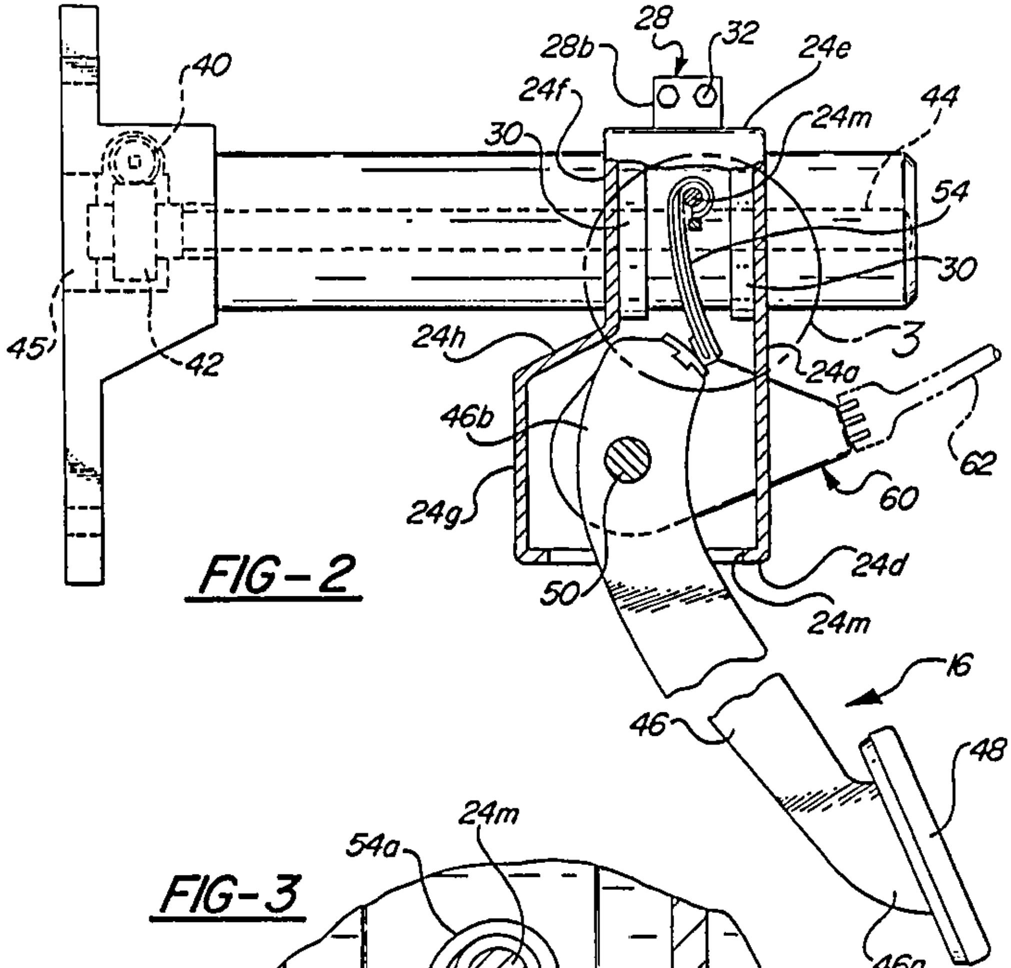
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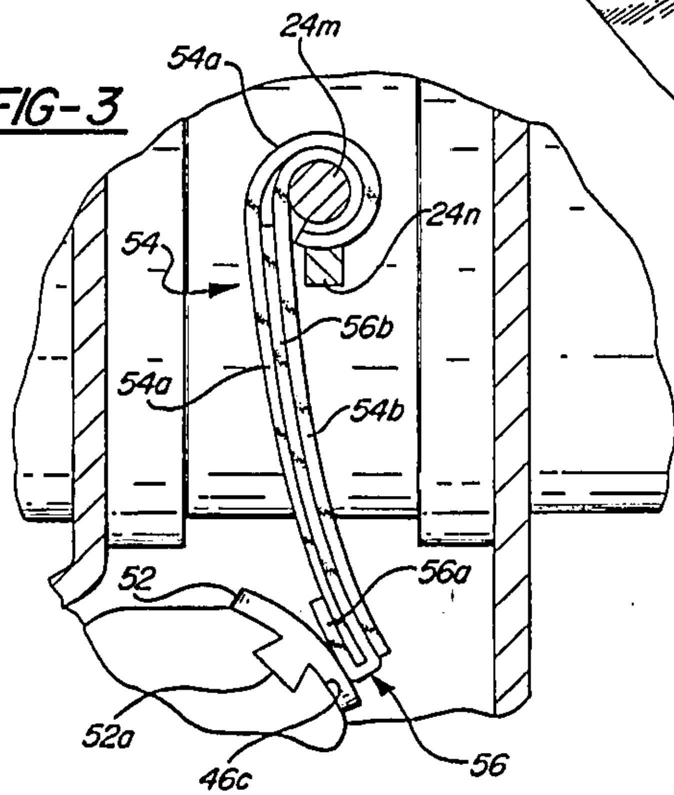
FIG-2

FIG-3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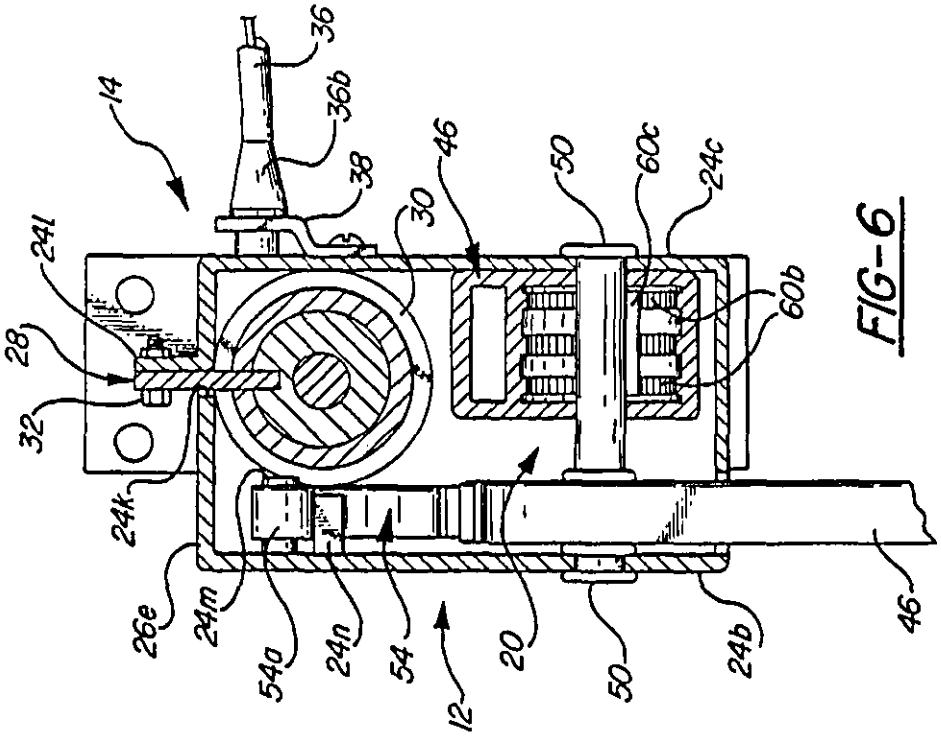

FIG-6

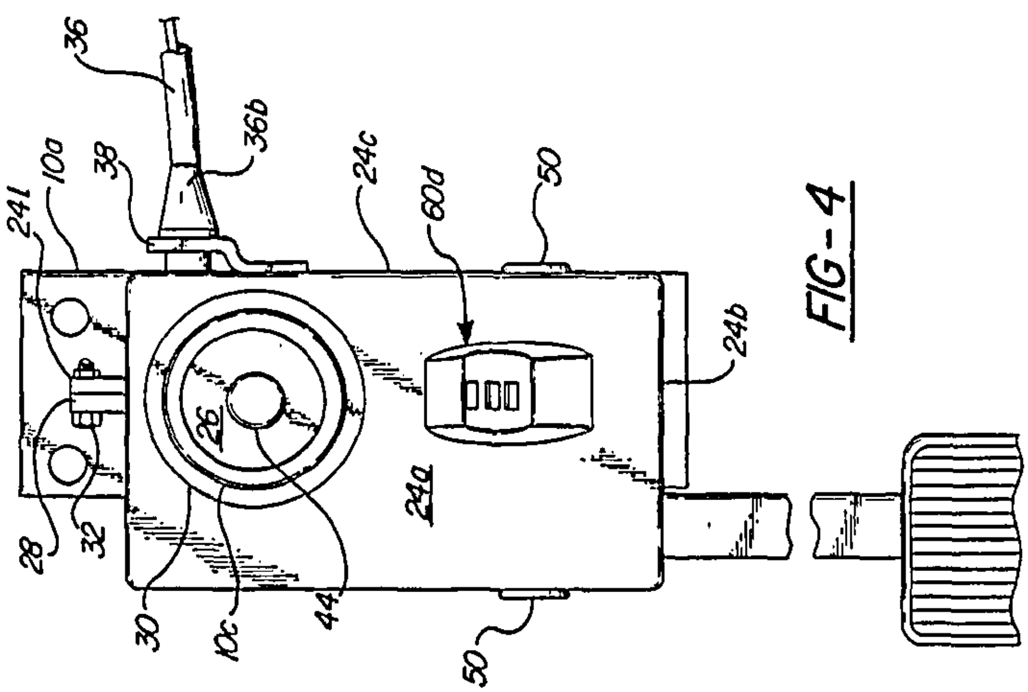

FIG-4

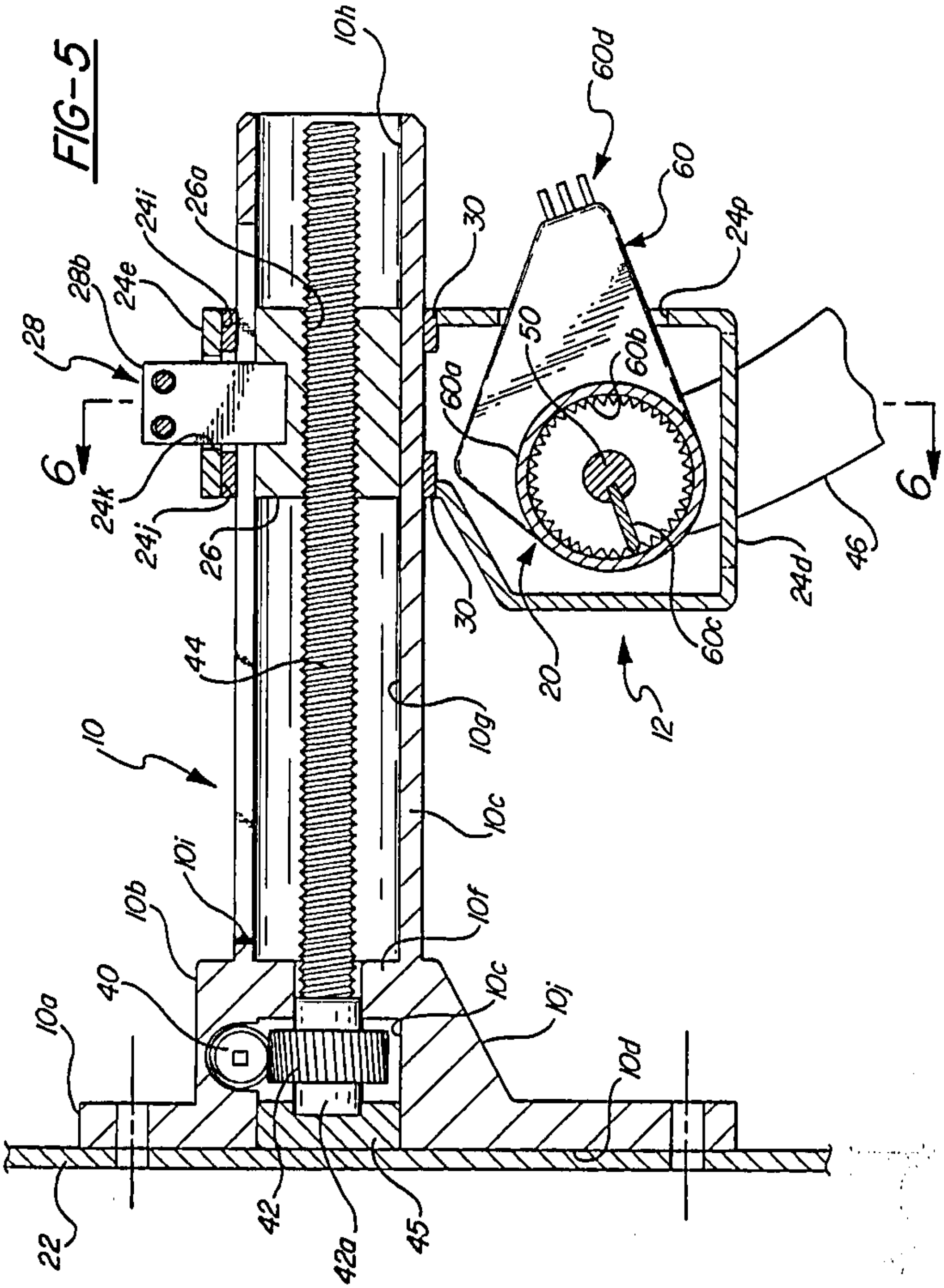
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FIG-5

ELECTRONIC ADJUSTABLE PEDAL ASSEMBLY

RELATED APPLICATION

This application is a continuation-in-part of U.S. patent application Ser. No. 08/513,017 filed on Aug. 9, 1995, now U.S. Pat. No. 5,632,183, and entitled Adjustable Pedal Assembly.

BACKGROUND OF THE INVENTION

This invention relates to control pedal apparatuses and more particularly to adjustment means for selectively adjusting the position of one or more of the control pedals of a motor vehicle.

In a conventional automotive vehicle pedals are provided for controlling brakes and engine throttle. If the vehicle has a manual transmission a clutch pedal is also provided. These pedals are foot operated by the driver. In order for the driver to maintain the most advantageous position for working these control pedals the vehicle front seat is usually slidably mounted on a seat track with means for securing the seat along the track in a plurality of adjustment positions.

The adjustment provided by moving the seat along the seat track does not accommodate all vehicle operators due to differences in anatomical dimensions. Further, there is growing concern that the use of seat tracks, and especially long seat tracks, constitutes a safety hazard in that the seat may pull loose from the track during an accident with resultant injuries to the driver and/or passengers. Further, the use of seat tracks to adjust the seat position has the effect of positioning shorter operators extremely close to the steering wheel where they are susceptible in an accident to injury from the steering wheel or from an exploding air bag. It is therefore desirable to either eliminate the seat track entirely or shorten the seat track to an extent that it will be strong enough to retain the seat during an impact. Shortening or eliminating the seat track requires that means be provided to selectively move the various control pedals to accommodate various size drivers.

Various proposals were made over a period of many years to provide selective adjustment of the pedal positions to accommodate various size drivers but none of these proposals met with any significant commercial acceptance since the proposed mechanisms were unduly complex and expensive and/or were extremely difficult to operate and/or accomplished the required pedal adjustment only at the expense of altering other critical dimensional relationships as between the driver and the various pedals. Recently a control pedal mechanism has been developed which is simple and inexpensive and easy to operate and that accomplishes the required pedal adjustment without altering further critical dimensional relationships as between the driver and the various pedals. This control pedal mechanism is disclosed in U.S. Pat. Nos. 4,875,385; 4,989,474 and 5,078,024 all assigned to the assignee of the present application. The present invention represents further improvements in adjustable control pedal design and specifically relates to an adjustable control pedal apparatus which is compatible with, and incorporates, a drive-by-wire arrangement in which the link between the pedal and the associated controlled device of the motor vehicle comprises an electronic signal rather than a mechanical linkage.

SUMMARY OF THE INVENTION

This invention is directed to the provision of a simple, inexpensive and effective apparatus for adjusting the control pedals of a motor vehicle.

More specifically, this invention is directed to the provision of an adjustable control pedal apparatus that is especially suitable for use in conjunction with a drive-by-wire throttle control.

The invention apparatus is adapted to be mounted on the body structure of the motor vehicle and includes a carrier, guide means mounting the carrier for fore and aft movement relative to the body structure, and drive means operative to move the carrier along the guide means. According to the invention, the pedal assembly further includes a pedal structure mounted on the carrier for movement relative to the carrier and means operative in response to movement of the pedal structure on the carrier to generate an electrical signal proportioned to the extent of movement of the pedal structure on the carrier. This arrangement provides a simple and effective means of generating an electronic control signal on an adjustable pedal assembly and ensures that the ergonomics of the control pedal will not vary irrespective of the position of adjustment of the pedal structure.

According to a further feature of the invention, the pedal structure is pivotally mounted on the carrier and the electric signal is generated in response to pivotal movement of the pedal structure on the carrier. This specific arrangement retains the customary pivotal movement of the control pedal and also maintains the constant ergometric operation of the control pedal assembly.

According to a further feature of the invention, the generator means includes a potentiometer mounted on the carrier whose setting is varied in response to pivotal movement of the pedal structure on the carrier. This specific arrangement provides a simple and effective means of generating the required electronic signal to provide drive-by-wire operation.

According to a further feature of the invention, the pedal structure includes a pedal arm and a pedal mounted on a lower end of the pedal arm; the pedal assembly further includes a feedback apparatus; and the feedback apparatus includes a spring mounted on the carrier and arranged to exert a spring force against the pedal arm that varies in response to pivotal movement of the pedal arm, a first friction surface defined on the pedal arm, and a second friction surface defined on the spring and arranged for wiping coaction with the first friction surface in response to pivotal movement of the pedal arm. This specific arrangement provides a simple and effective means of providing the desired feel or feedback to the operator upon movement of the pedal and further provides the desired hysteresis effect.

According to a further feature of the invention the first friction surface is defined by a cam surface on the pedal arm; the spring comprises a leaf spring fixedly secured at one end thereof to the carrier and defining a free end; and the second friction surface is defined on the free end of the leaf spring. With this arrangement, pivotal movement of the pedal arm generates wiping action between the cam surface and the free end of the spring and varies the extent of flexing of the spring about its fixed end.

According to a further feature of the invention, the feedback apparatus means further includes a first resistance plate mounted on the upper region of the pedal arm and a second resistance plate mounted on the free end of the leaf spring and biased against the first resistance plate. This arrangement allows the resistance offered to the pivoting pedal to be varied either by varying the spring characteristics of the spring or by varying the resistance characteristics of the resistance plates.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of an electronic adjustable pedal assembly according to the invention;

FIG. 2 is a fragmentary side view of the pedal assembly;

FIG. 3 is a detail view taken within the closed line 3 of FIG. 2;

FIG. 4 is an end view of the pedal assembly;

FIG. 5 is a cross-sectional view taken on line 5—5 of FIG. 1; and

FIG. 6 is a cross-sectional view taken on line 6—6 of FIG. 5.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention control pedal assembly, broadly considered, is intended to allow efficient fore and aft movement of the pedal assembly to accommodate operators of varying anatomical dimension and is operative to generate an electronic or drive-by-wire signal in response to pivotal movement of the pedal assembly while retaining the same ergometric operation of the pedal irrespective of the position of adjustment of the pedal.

The pedal assembly includes a support structure **10**, a carrier assembly **12**, a drive assembly **14**, a pedal assembly **16**, a resistance or feedback assembly **18**, and a generator means **20**.

Support structure **10** may be formed as two or more parts which are suitably joined together or may, as shown, be formed as a single integral unitary member in a casting or forging operation. Structure **10** includes a bracket portion **10***a*, a transmission housing portion **10***b*, and a guide rod portion **10***c*.

Bracket portion **10***a* is adapted to be suitably secured to the dash panel **22** of the associated motor vehicle utilizing suitable fastener means in known manner.

Transmission housing portion **10***b* extends rearwardly from bracket portion **10***a* and has a generally cubicle configuration defining a hollow **10***c* opening at the front face **10***d* of bracket **10***a* and further defining a central bore **10***e* in a rear wall **10***f* of the housing portion.

Guide rod portion **10***c* extends rigidly rearwardly from the rear wall **10***f* of the transmission housing portion, is hollow so as to provide a tubular configuration defining a central circular bore **10***g* concentric with bore **10***e*, is open at its rear end **10***h*, and includes an upper axial slot **10***i* extending from a location proximate the transmission housing wall **10***f* to a location proximate guide rod rear end **10***h*.

Carrier assembly **12** includes a housing **24**, a nut **26**, and a key **28**.

Housing **24** may be formed as a casting, forging or stamping, and is designed to move slidably along the guide rod portion **10***c* of support structure **10**. Housing **24** includes a rear wall **24***a*, side walls **24***b* and **24***c*, a bottom wall **24***d*, a top wall **24***e*, and a front wall including an upper portion **24***f*, a lower portion **24***g*, and an angled intermediate connector portion **24***h*. A circular opening **24***i* is provided in rear wall **24***a* proximate top wall **24***e* and a circular opening **24***j* is provided in front wall upper portion **24***f* proximate top wall **24***e* in axial alignment with opening **24***i*. Housing **24** is mounted on the guide rod portion **10***c* of support structure **10** with guide rod portion **10***c* passing through apertures **24***i* and **24***j* and bushings **30** positioned in apertures **24***i* and **24***j* in sliding engagement with the outer periphery of guide rod portion **10***c* so as to mount the housing for sliding movement along the guide rod. Angled front wall **24***h* is complementary to the angled lower surface **10***j* of the transmission housing portion **10***b* of support structure **10** so that the housing **24** may move into nesting relation with respect to the support structure with the housing in its extreme forward position.

Nut **26** is circular, is mounted for sliding movement in circular bore **10***g* of support structure **10**, and defines a central threaded bore **26***a*.

Key **28** is seated at its lower end **28***a* in a notch **26***b* in the upper periphery of nut **26** and passes upwardly through slot **10***i* and through an opening **24***k* in top housing wall **24***e* for securement at its upper end **28***b*, by fasteners **32**, to a flange **241** upstanding from housing top wall **24***e*. Key **28** thus lockingly interconnects nut **26** and housing **24** so that movement of nut **26** in bore **10***g* is imparted to housing **24** so as to move housing **24** axially along guide rod portion **10***c*.

Drive assembly **14** includes a motor **34**, a cable **36**, a bracket **38**, a worm **40**, a worm gear **42**, and a screw shaft **44**.

Motor **34** comprises a suitable electric motor, with position memory if required, and is suitably secured to dash panel **22** proximate the bracket portion **10***a* of the support structure.

Cable **36** comprises a well-known bowden cable and is drivingly secured at one end **36***a* to the output shaft of motor **34**. Bracket **38** is secured to an outer face of transmission housing **10***b* and mounts the other end **36***b* of cable **36**.

Worm **40** is suitably journalled in transmission housing **10***b* in overlying relation to cavity **10***c* and is drivingly connected to cable end **36***b*.

Worm gear **42** is journalled in cavity **10***c* in meshing engagement with worm **40** and includes a front trunion **42***a* journalled in a bearing **45** positioned in the open front end of cavity **10***c* and a rear trunion **42***b* journalled in a counterbore **10***k* in transmission rear wall **10***f*.

Screw shaft **44** extends rearwardly from worm gear **42** centrally within support structure bore **10***g* and passes threadably through the threaded central bore **26***a* of nut **26**.

It will be seen that actuation of motor **34** has the effect of rotating screw shaft **44** to thereby move nut **26** and housing **24** fore and aft along guide rod **10***c* with the extent of forward and rearward movement defined and limited by engagement of key **28** with the front and rear ends of slot **10***i*.

Pedal assembly **16** includes a pedal arm **46** and a pedal **48** secured to the lower end **46***a* of the pedal arm. Pedal arm **46** passes upwardly through a slot **24***m* in the lower housing wall **24***d* for pivotal mounting at its upper end **46***b* to housing side walls **24***b* and **24***c* via a pivot shaft **50**.

Resistance assembly **18** includes a pedal arm friction cam plate **52**, a leaf spring **54**, and a spring friction cam plate **56**. Resistance assembly **18** is intended to provide feedback or "feel" to the operator to replace the feedback normally provided by the mechanical linkage interconnecting the pedal and the controlled device such as the fuel throttle. With a mechanical linkage, the pedal pressure required when advancing the accelerator pedal is greater than that required to maintain a fixed position. This difference is often referred to as due to the hysteresis effect. This effect is important in maintaining the accelerator pedal in position while driving at a relatively constant speed and it must also be considered in achieving a desired deceleration time. The pressure which must be applied in accelerating is easily borne but if the back pressure of an accelerator spring produced the same effect during the time it was required to retain or maintain speed it would soon become uncomfortable for the operator to maintain a relatively constant speed. The hysteresis effect provides relief. It lessens the load required to maintain a setting of the accelerator yet there is still force to cause

reverse pedal action when the foot applied pressure is removed. Resistance assembly 18 provides the "feel" of a mechanical linkage including the desired hysteresis effect to relieve operator fatigue.

Pedal arm friction cam plate 52 may be formed, for example, of a plastic material such as Delrin® and is secured to an upper cam edge 46*c* of the pedal arm via a dovetail connection 52*a*.

Spring 54 comprises a laminated leaf spring and includes a curl 54*a* at its upper end wrapped around a pin 24*m* projecting inwardly from housing side wall 24*b*. A nub 24*n* projects inwardly from housing side wall 24*b* below pin 24*m* and coacts with pin 24*m* to trap the end tip 54*b* of curl 54*a* to fixedly secure the upper end of the spring to housing side wall 24*b*.

Spring friction cam plate 56 may be formed, for example, of a glass filled nylon material and includes a working portion 56*a* suitably secured to the lower end 54*b* of leaf spring 54 and a tail portion 56*b* passing upwardly between the leaves 54*a*, 54*b* of leaf spring 54. The parts are configured such that with the pedal 48 in its upper or rest position, as seen in FIG. 1, friction plate working portion 56*a* is urged against friction plate 52 by spring 54 so as to resist pivotal movement of the pedal assembly to an operative position with the resistance being constituted both by the increasing resistance force of the spring 54 and by the frictional resistance force between plates 52 and 56*a* generated by the wiping or camming action of plate 52 against plate 56*a* as the pedal arm pivots about the axis of pivot shaft 50. Upon release of pressure on the pedal, the frictional resistance force between plates 52 and 56*a* become subtractive rather than additive with respect to the force of spring 54, thereby creating the desired hysteresis effect. The materials of cam plates 52 and 56*a* may be selectively varied to selectively vary the friction levels and hence the damping or hysteresis effect provided by the rubbing plates.

Generator means 20 comprises a potentiometer 60 positioned within the hollow of housing 24 and suitably secured to housing side wall 24*c*. Potentiometer 60 includes a central shaft, constituted by the pivot shaft 50, a housing 60*a* concentric with shaft 50, a plurality of resistance elements 60*b* mounted circumferentially around the inner periphery of housing 60*a* in side-by-side relation, a wiper arm 60*c* mounted on shaft 50 and operative to electrically slidably engage the resistance elements 60*b* in response to pivotal movement of shaft 50, and an outlet 60*d* projecting rearwardly through opening 24*p* in housing rear wall 24*a* and electrically connected to wiper 60*c* and resistance elements 60*b* in a manner such that the electrical signal appearing at the outlet 60*d* varies in proportion to the extent of pivotal movement of the pivot shaft 50. It will be seen that pivotal movement of pedal 48 has the effect of rotating pivot shaft 50 and thereby varying the electrical signal appearing at the potentiometer outlet 60*d* so that the signal appearing at outlet 60*d* is at all times proportioned to and indicative of the pivotal position of the pedal. It will be understood that electric power is suitably supplied to potentiometer 60 and an electrical conduit 62 is suitably connected to potentiometer outlet 60*d* and extends to the vehicle function or accessory, such as the vehicle throttle, that is being electrically controlled by the pedal assembly.

In operation, the position of the pedal 48 relative to the operator is selectively adjusted by selectively energizing motor 34 to selectively move nut 26 forwardly and rearwardly within guide rod bore 10*g* and thereby, via key 28, move the pedal assembly selectively forwardly and rearwardly along guide rod 10*c* with the limits of forward and rearward movement determined by engagement of the key with the respective forward and rearward ends of the slot 10*i*. In any position of adjustment of the pedal, actuation of the pedal or release of the pedal results, in the manner previously described, in the generation of an output signal at the outlet 60*d* proportioned to the extent of pivotal movement. Since the pivotal movement of the pedal arm is precisely the same in any position of adjustment of the pedal structure, the ergometrics of the assembly do not vary irrespective of the position of adjustment of the pedal assembly and irrespective of the anatomical stature of the operator.

As the pedal is moved downwardly, a "feel" is imparted to the pedal, simulating the feel of a mechanical linkage between the pedal and the controlled vehicle system, by the combined effect of flexing of the leaf spring 54 and frictional sliding or wiping engagement between the friction plates 52 and 56*a*. Further, as the pedal is released or allowed to return, the frictional force becomes subtractive rather than additive with respect to the spring force, thereby creating the desired hysteresis effect. The amount of feel imparted to the pedal can thus be precisely adjusted by adjusting the spring rate or other parameters of leaf spring 54, and/or by adjusting the materials or other parameters of friction plates 52 and 56*a*, and/or by adjusting the rise of cam edge 46*c*, thereby rendering it relatively easy to fine tune the system to achieve any desired feel and any desired hysteresis effect.

The invention will be seen to provide an electronic adjustable pedal assembly for a motor vehicle in which the assembly may be readily adjusted to accommodate operators of varying anatomical dimensions and in which the ergometrics of the system remain constant irrespective of the position of adjustment of the pedal structure.

Whereas a preferred embodiment of the invention has been illustrated and described in detail, it will be apparent that various changes may be made in the disclosed embodiment without departing from the scope or spirit of the invention. For example, although the invention pedal assembly has been indicated for use in controlling the throttle of the associated vehicle, the invention pedal assembly may be used to electrically control a wide variety of vehicle functions or accessories. Further, although the resistance assembly 18 has been illustrated as providing the damping for an adjustable pedal assembly, it will be apparent that this resistance assembly can also be utilized to provide damping for a non-adjustable pedal assembly.

What is claimed is:

1. An adjustable pedal assembly for a motor vehicle adapted to be mounted on a body structure of the vehicle and operative to generate a control signal for controlling an associated device of the motor vehicle, said assembly comprising:

a carrier;

guide means mounting the carrier for fore and aft movement relative to the vehicle body structure;

drive means for moving the carrier along the guide means;

a pedal structure mounted on the carrier for movement relative to the carrier; and

generator means operative in response to movement of the pedal structure relative to the carrier to generate an electric control signal proportioned to the extent of movement of the pedal structure relative to the carrier;

the carrier defining a smooth bore and a threaded bore;

the guide means including a guide rod slidably received in the smooth bore; and

the drive means including a screw shaft threadably received in the threaded bore.

2. An adjustable pedal assembly for a motor vehicle adapted to be mounted on a body structure of the vehicle and operative to generate a control signal for controlling an associated device of the motor vehicle, said assembly comprising:

a carrier;

guide means mounting the carrier for fore and aft movement relative to the vehicle body structure;

drive means for moving the carrier along the guide means;

a pedal structure including an upper end pivotally mounted on the carrier; and

generator means operative in response to pivotal movement of the pedal structure on the carrier to generate an electric control signal proportioned to the extent of pivotal movement of the pedal structure;

the carrier defining a smooth bore and a threaded bore;

the guide means including a guide rod slidably received in the smooth bore; and

the drive means including a screw shaft threadably received in the threaded bore.

3. An adjustable pedal assembly for a motor vehicle adapted to be mounted on a body structure of the vehicle and operative to generate a control signal for controlling an associated device of the motor vehicle, said assembly comprising:

a carrier;

guide means mounting the carrier for fore and aft movement relative to the vehicle body structure;

drive means for moving the carrier along the guide means;

a pedal structure including an upper end pivotally mounted on the carrier;

generator means operative in response to pivotal movement of the pedal structure on the carrier to generate an electric control signal proportioned to the extent of pivotal movement of the pedal structure;

resistance means operative to resist pivotal movement of the pedal structure;

the pedal structure including a pedal arm and a pedal mounted on a lower end of the pedal arm;

the resistance means including a leaf spring fixedly mounted at one end thereof on the carrier and having a free end biased against an upper region of the pedal arm;

the resistance means further including a first resistance plate mounted on the upper region of the pedal arm and a second resistance plate mounted on the free end of the leaf spring and biased against the first resistance plate.

4. An adjustable pedal assembly for a motor vehicle adapted to be mounted on a body structure of the vehicle and including a carrier, guide means mounting the carrier for fore and aft movement relative to the body structure, and drive means operative to move the carrier along the guide means, characterized in that:

the pedal assembly further includes a pedal structure mounted on the carrier for movement relative to the carrier and generator means operative in response to movement of the pedal structure on the carrier to generate an electrical signal proportioned to the extent of movement of the pedal structure on the carrier;

the guide means comprises a guide rod;

the carrier includes an upper portion mounted on the guide rod for sliding fore and aft movement along the guide rod;

the pedal structure includes a pedal arm having an upper end mounted on a lower portion of the carrier;

the pedal arm is pivotally mounted on the lower carrier portion;

the generator means includes a potentiometer mounted on the lower portion of the carrier and means operative in response to pivotal movement of the pedal arm to vary the setting of the potentiometer;

the guide rod comprises a hollow rod;

the carrier further includes a nut slidably positioned within the hollow of the guide rod and means connecting the nut to the upper portion of the carrier so that sliding movement of the nut within the guide rod moves the carrier fore and aft along the guide rod;

the drive means includes a screw shaft threadably received in the nut and means operative to rotate the screw shaft.

* * * * *

UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF MICHIGAN
SOUTHERN DIVISION

TELEFLEX INCORPORATED,

Plaintiff,

v.

KSR INTERNATIONAL CO.,

Defendant.

Case No. 02 74586

Hon. Lawrence P. Zatkoff

Magistrate Judge Pepe

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AFFIDAVIT OF CHARLES MEIER

______I, Charles Meier, being duly sworn, depose and state as follows:

1. I have personal knowledge of the facts stated in this Affidavit, I am competent to testify to those facts, and I would testify to them if called upon to do so.

2. I am Director of Pedal Engineering for Teleflex Incorporated.

3. The adjustable pedal assembly design referenced in the Engelgau patent (U.S. Patent No. 6,237,565) has been placed in Ford's U-137/P-131 program.

4. The U-137/P131 program vehicles are the Ford Excursion, F-250, and F-350.

5. To date, Teleflex has shipped approximately 150,000 adjustable pedal units to Ford for the U-137/P-131 program.

Charles Meier

Subscribed and sworn to before me
on this 11th day of August, 2003.

Notary Public
Macomb/Acting in Oakland County,
My Commission Expires: 11-29-2003

MICHELE A. CHIRIKAS
Notary Public, Macomb County, MI
My Commission Expires Nov. 29, 2003
Acting in Oakland County, MI